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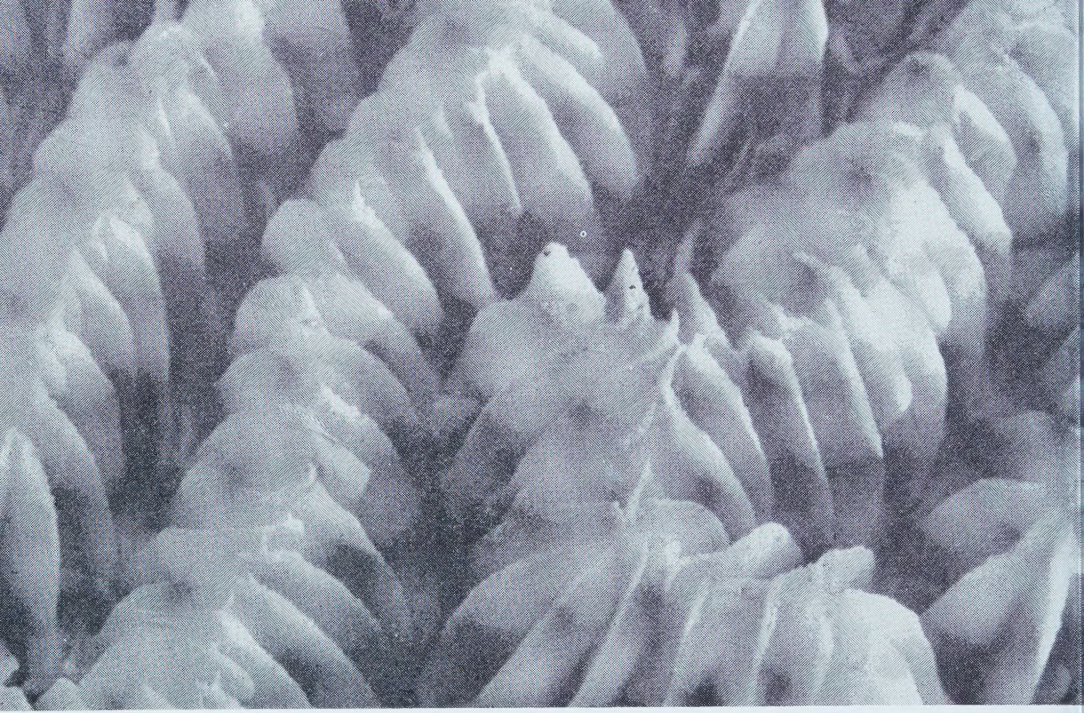
Sea Frontiers

Bulletin of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION

August, 1958

Volume 4, No. 3



SPACE TRAVELLER'S CLOSE-UP *of the moon? That would be a reasonable surmise, but the photograph actually shows the ridged surface of an Atlantic reef coral* (Meandrina meandrites), *or rather its skeletal remains after removal from the sea, drying and cleaning. Corals are beautifully colored in life. Their dead skeletons are wonderful examples of design and pattern in nature. (Frederick M. Bayer)*

FRONT COVER. *The sea shore, where land and water meet, is of special interest to marine biologists today, because of the encroachments of man-made fills and bulkheads to the detriment of marine life. Here, by the dawn's early light, fishermen cast their lines into the booming surf along Nauset Beach, near Truro, Massachusetts, on a day that has all the earmarks of favorable fishing, swimming and shelling. (Massachusetts Chamber of Commerce)*

BACK COVER. *In addition to scientific knowledge, oceanography involves a great deal of practical experience and know-how. An attentive youth listens as a veteran sailor passes along some of the fine points of fishing, sailing and navigating he has acquired from many years on the water. There is an increasing demand for oceanographers and marine biologists. Will the lad in the picture become one? (Johnson Motors)*

SEA FRONTIERS

Bulletin of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION

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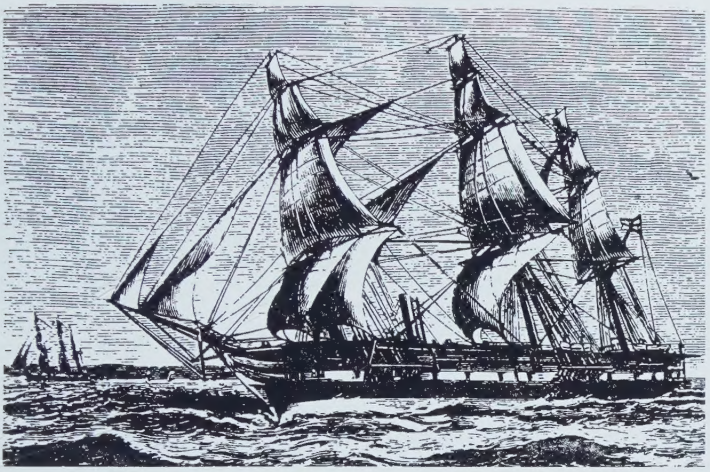

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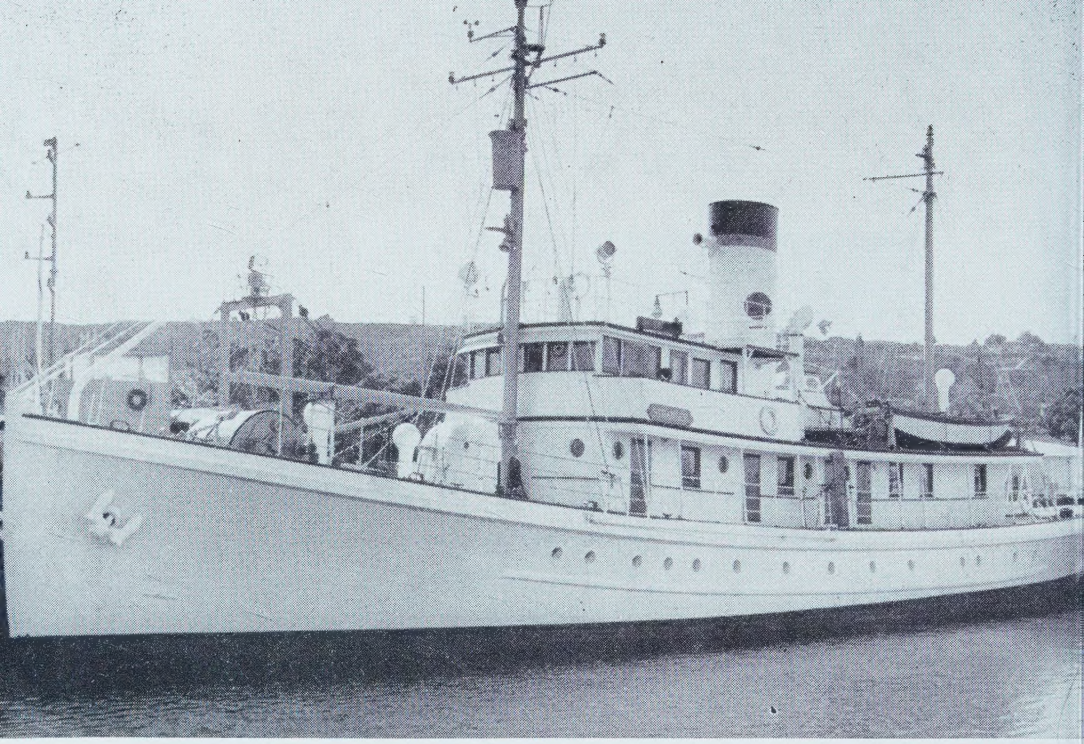


OCEANOGRAPHIC RESEARCH *is still vitally important to man, although it has been momentarily overshadowed by "sputniking." The research vessel* STRANGER, *gift to an oceanographic institute by a private donor, indicates that the general public remains aware of the significance of the sea frontier at our doorstep. This is encouraging because a great deal more research of this and similar kinds must be undertaken before oceanographers can find the answers to such problems as the amount of minerals dissolved in sea water, ocean currents in relation to weather and navigation, undersea warfare and communications, and the disposal of radioactive wastes in the deep sea. (Scripps Institute of Oceanography)*

Of Space and the Sea

LETTERS FROM MEMBERS are always pleasant to receive and, more often than not, they contain stimulating ideas or information. A recent arrival in the mail pointed out that the development of the airplane, which one might expect to lessen the role of the sea to travellers, has actually increased its importance as a highway, and has made the study of oceanography more necessary than ever before. His argument was based on the fact that growth of air travel has brought about increasing numbers of transocean flights with the result that more people than ever before are crossing the oceans. We are also told by air line officials that one of the busiest air routes in the world is between New York and Miami, a route which flies over the Atlantic Ocean almost the entire distance.

Harbors From Atoms

Other ways in which the changing patterns of civilization unexpectedly involve the sea come daily to the at-

tention. For example, the age of nuclear energy has brought into focus such obvious and dramatic matters as the procession of expensive man-made satellites, leading up to the proposed delivery of a hydrogen bomb to the moon.

But along with headlines about space gadgetry and annihilatory weapons, there appear modest announcements about nuclear applications of immediate practical value, concerning the sea. A recent suggestion is the use of an atomic explosion in order to dig an artificial ship harbor in the coast of Alaska, 100 miles north of the Arctic Circle. The National Geographic Society points out that Alaska possesses great quantities of coal, oil, asbestos, zinc, tin, copper, gold and other ores. Thus this application of atomic energy would provide for development of mineral wealth which is prevented by lack of ports at present.

The harbor, if built, may eventually serve other purposes. For instance, much has been written about the possibilities of harvesting plankton from the sea and, if this is ever accomplished, it may well begin in Alaska, since some of the greatest concentrations of this ocean pasturage are found in Arctic waters.

The more obvious reasons for our interest in the ocean, such as great fishery resources, the vast amount of minerals dissolved in sea water, ocean currents in relation to weather and navigation, undersea warfare and communication, and recreation, to name a few—to these are added today such new ones as the necessity of disposing of radioactive wastes in the deep sea and the consequent need to know where and how deep ocean currents might render them dangerous by bringing them back into circulation.

High Cost of Moon-Mice

There is a danger, however, that the more spectacular appeal of nuclear energy and space ships may result in an overbalanced attitude towards scientific endeavor, whereby the more immediately valuable fields of discovery, among which are included marine biology and oceanography, might suffer from inadequate manpower and funds, while the high price of transporting mice to the moon passes unnoticed in the general hysteria of the new rocket age. It is important that we do not lag behind in exploring these new scientific frontiers, but equally important that in doing so, we do not neglect our more immediate scientific tasks.

Already, fantastic though it may appear, it is a fact that we know more about the surface of the moon than we know about certain areas of the sea floor. Yet plans have been proposed whereby a single rocket to the moon would be launched at a cost of nearly one hundred times the amount devoted annually to the entire field of oceanography.

Work of the Foundation

Among other correspondents, a new member wishes to know more of the activities of the Foundation. It may therefore be appropriate here to report to members what efforts are being made to encourage and develop scientific research and exploration of the adjacent sea frontier in contrast

to the distant celestial frontier.

Direct aid to research is being given in various ways and is not limited to any one institution or region. For instance, a fund has been set up to assist the exchange of scientific personnel between the United States and the Scandinavian countries. During the coming year this will pay part of the expenses of sending Scandinavian oceanographers to the World Oceanographic Congress in New York. International exchange of ideas and increased contact between scientists of different countries should greatly stimulate ideas in research.

Specific types of research, such as studies of the sediments of the sea floor, and their relation to life in the sea, have been subsidized by financial grants made by the Foundation to research institutions. These sediments are indirectly important to an understanding of the nature of rock strata in which oil fields occur. The investigation of large oceanic fishes, including the giant bluefin tuna, the blue marlin and the sailfish has also been aided financially. One of the most interesting objects of research supported by Foundation funds has been the life history of the tarpon, which lives in the sea but is sometimes found completely cut off in fresh water ponds.

Scholarships for Science Students

Gifted students are often prevented from entering a scientific career by the expensive and lengthy training required. It is therefore particularly gratifying to report that through the generosity of a member, a scholarship fund is being established to aid those who wish to become fishery biologists or ichthyologists. Preference will be given to students who are the sons of commercial fishermen or fishing guides, or else are experienced anglers themselves.

Another member, also interested in the training of marine scientists, has endowed a professorship in marine ichthyology which will insure both teaching and research in matters concerning salt water fishes. In other ways various members have themselves directly helped to further marine science from Africa to Chile by actual participation.

International cooperation is perhaps more desirable in the marine sciences than in others and it is therefore good to report the work of John Manning, a member of the Board of the Foundation, who has been actively engaged in fishery exploration off the coast of Chile in cooperation with the University of Chile.

Game Fish Meetings

Increasing our knowledge about the ocean game fishes is a scientific task, but is nevertheless considerably augmented by the practical experience of guides and anglers. For this reason the Foundation, during the past two years, has sponsored an international conference at which scientists, anglers and professional fishermen have exchanged a considerable number of valuable ideas, as well as planning for cooperation in collecting needed specimens.

The time when scientists pursued their research in an isolated world of their own has passed and it is recognized today that there is a definite

need to pass on to the general public an account of the activities and discoveries of science. This function the Foundation has endeavored to carry out by way of its publications.

Sea Frontiers is now in its fourth year and membership-reader growth is considerable. Still further growth is needed before it will be possible to increase the number of pages and the number of issues, and to introduce full color illustrations. Thus the efforts of our members to introduce new ones will be of benefit to all concerned. Meanwhile greatly increased participation on the part of scientific organizations and individuals is making it easier for the editorial staff to provide authoritative articles on progress and discovery along the ocean frontiers of science.

Moving Pictures

Many members have made use of a colored sound moving picture, *And Now, The Sea.* This is available on loan merely for the cost of mailing. It shows the work of a modern marine laboratory and demonstrates something of the career opportunities available to students. The splendid reception given to this movie by angling

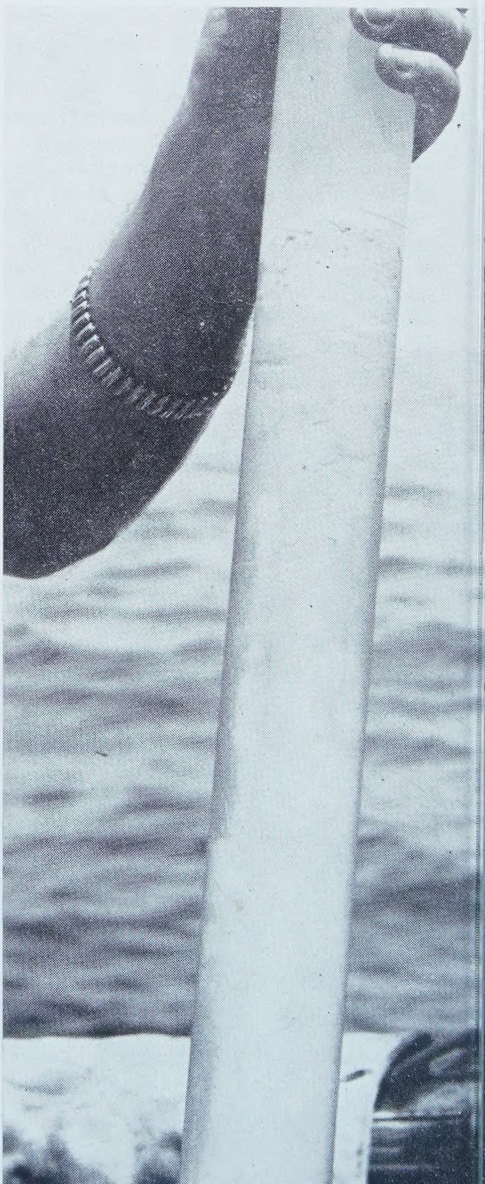
COOPERATION BETWEEN ANGLERS AND SCIENTISTS. *A marine biologist (left) interviews a charterboat captain to obtain information on his daily catches as well as to obtain samples for study. This information is secured in connection with statewide surveys of salt water game fish and fishing. The International Oceanographic Foundation has organized an unusual meeting, the International Game Fish Conference, to encourage such cooperation. Exchange of ideas and experiences between game fishermen and scientists has proved both stimulating and enjoyable, and information was secured that might otherwise have been lost. (Marine Laboratory, University of Miami)*

and yachting clubs, high school classes and by business and social clubs is indicated by the fact that four additional copies have been purchased in order to supply all loan requests.

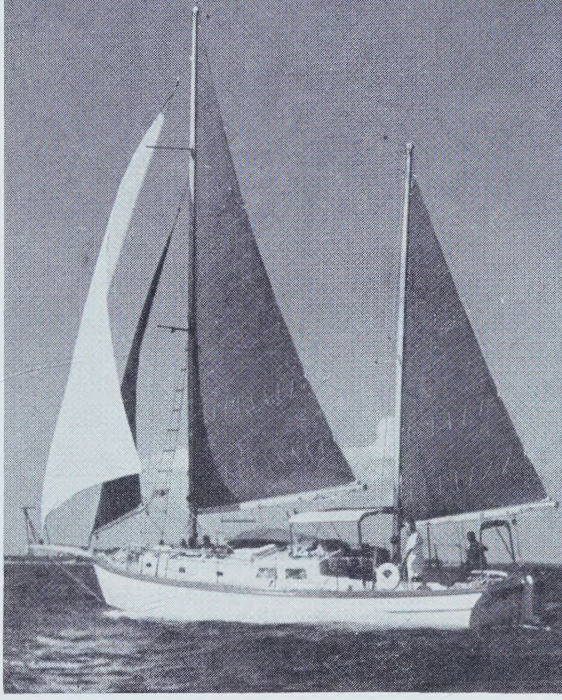
Also in the realm of information service are the numerous replies to inquiries seeking factual information about the sea. In order to take care of one frequent request, the Foundation has published a brief folder on the winds and currents that may be encountered in the ocean races of the southern conference. Yachtsmen in turn have done much to help oceanography. Some, with sufficiently large vessels of their own, have participated actively in seagoing expeditions. Others have donated their vessels for use in research. The government recognizes the importance of research and education by allowing tax deductions in such cases.

Corporations Aid Science

Although the backbone of the Foundation is the growing number of annual members, the financial help given by individuals in a position to apply their generosity to its work and to the work of research institutions in general has been considerable. In the past it was true that much of basic science depended upon the patronage of men of wealth. Today, however, more and more of the responsibility for keeping research and discovery in the realm of free enterprise is being shouldered by industrial corporations.



DEEP SEA CORE. *An excellent sample of the sea floor, taken in the Tongue of the Ocean, Bahama Islands, during a scientific expedition. Such specimens as this make it possible to learn, not only the nature of the sea floor, but the changes which took place in the seas and their beds millions of years ago. Fantastic as it may appear, we know more of the surface of the moon than we do about certain areas of the sea floor. Yet plans have been proposed whereby a single rocket to land upon the moon would be launched at a cost several hundred times in excess of what is devoted to the entire field of oceanography in twelve months. (M. Woodbridge Williams, National Geographic Society)*



THEY ALSO SERVE. *Members of the International Oceanographic Foundation are also playing a part in the development of modern oceanography, some of them contributing funds and others ships, such as* SEA GOOSE. *This splendid diesel auxiliary ketch was given by Mr. Seward Johnson, of Hobe Sound.* SEA GOOSE *at present is actively working in Bahamian waters, making a scientific study of coral reefs for the University of Miami. (Fred Mizer)*

This attitude of civic responsibility is encouraged by the government, which allows contributions up to 5% of net profit to be deducted as business expenses. Among the industries which have taken advantage of this provision and become Corporate Associates of the Foundation are a major steamship line and an oil company. Their contributions have made possible the support of student training as well as specific research projects.

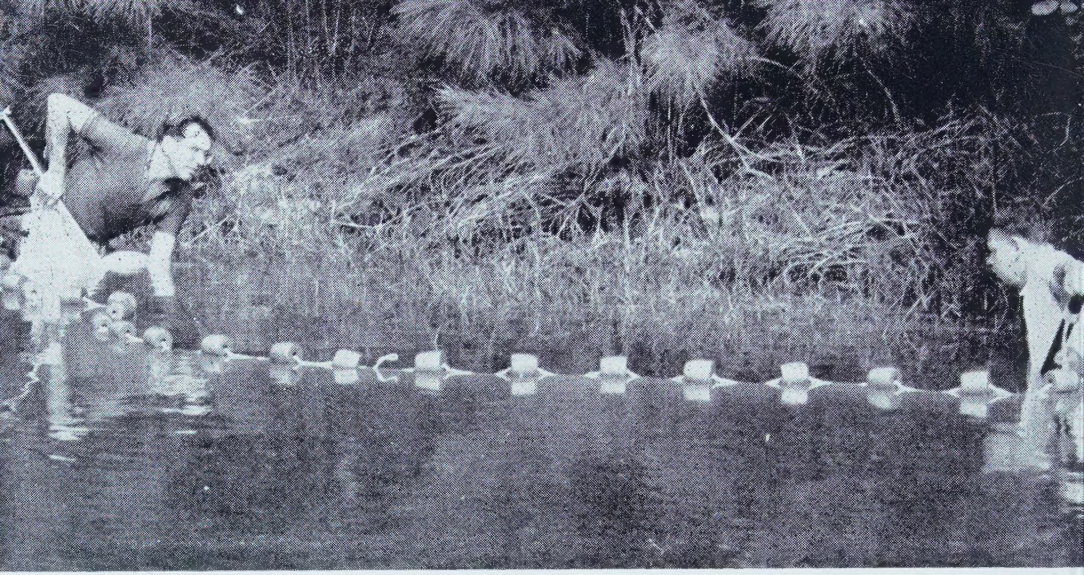
The Role of Industry

When we think of the future, it is clear that the participation of individuals and corporations, according to their degree of interest and ability, is vital to science, lest the increasing amount of government support result in overmuch government control. It is also important that such magazines as *Sea Frontiers* provide information and news which will give a proper perspective to the part played by such sciences as those of the sea. While we grope with highpowered rockets for the stars it is surely wise to keep a foot on the ground and, to stretch the metaphor further, one toe in the water.

Nature achieves a balance by the hard inexorable method of elimination of the unfit, by trial and error. Man, if he but take a long range view, can achieve a balance in science if he will give air, land and sea their proportional share of time, talent, funds.

King-Size Herring

Herring came big in those days—about 100,000,000 years ago. Fossil remains of Xiphactinus, a member of the herring tribe that might be described as an "overgrown sardine," have been found in Kansas and Texas, and their dimensions rival those of some of the largest sharks of the present. Within the rib case of a 16-foot fossilized specimen, paleontologists of the Smithsonian Institution found the skeleton of a smaller fish that had been swallowed, but whose bones had not been digested.



SEINING A BRACKISH POND. *Using a large net with cork floats, the authors (Randall at left, Moffett on right) search for young tarpon. The tarpon is one of the few fishes with the amazing facility of being equally at home in freshwater or salt. The tarpon's lung-like air bladder enables it to survive also in waters of low oxygen content, such as stagnant ponds, where other fishes would perish. (Walter R. Courtenay)*

The Tarpon Has Many Secrets

By JOHN E. RANDALL *and* ALAN W. MOFFETT

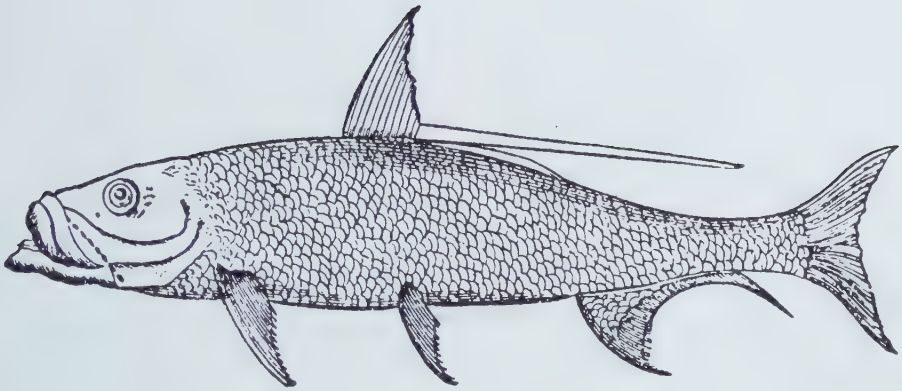
FEW FISHES have had so much written about them, with so little in the way of facts, as the tarpon. This magnificent silvery fish, considered without peer among game fishes for its spectacular fighting ability, has long been a favored subject of the so-called "popular writers," in publications of all kinds, from sports magazines to novels.

Where Biologists Fear to Tread

Of course, much that has been written merely describes the fantastic struggles put up by the tarpon in its attempts to shake off the hook, or outlines better ways to entice this wary fish, or lauds certain tarpon-fishing areas, such as Boca Grande, the Florida Keys, Port Aransas, Texas, the Isle of Pines, and Panuco River, Mexico.

However, some authors are now venturing boldly into a realm of biology where biologists themselves fear to tread. The life history of the tarpon remains largely unknown. This does not infer that scientific research has not been attempted, for it has. But the tarpon has been about as elusive to the biologist as it has to fishermen. Even so, the established facts make an interesting story.

The first description of the tarpon, under the odd name Camaripuguacus, appeared in 1648, in Marcgrav's "History of Brazil." Like many early illustrations of fishes, this one bordered on the fanciful. But the exaggerated dor-



CAMARIPUGUACUS (1648)

EARLIEST KNOWN PICTURE OF A TARPON *appeared in Marcgrav's "History of Brazil," bearing the odd name* Camaripuguacus, *a far cry from its present scientific name,* Megalops atlantica. *The description of its large toothless mouth and big scales which seem coated in pure silver, leave no doubt as to its identity.*

sal filament, and the description, which mentions a large toothless mouth and big scales which seem coated in pure silver, leave no doubt as to the identity of the fish.

The tarpon has had many colloquial names in America, among them tarpum, tarpom, jew fish, grand ecaille, grand ecoy, big scale, silver fish, and silver king, but gradually tarpon has supplanted the others. This name is believed to be of Indian origin.

Big Glaring Eye

Cuvier and Valenciennes bestowed the scientific name *Megalops atlantica,* in 1846, making reference to the large eye. It is a fitting name, for the big glaring eye of a tarpon as the gigantic fish leaps high in the air and dangerously near a boat, has startled more than one novice fisherman.

One other member of the genus, *(Megalops cyprinoides),* popularly known as the ox eye, lives in the Indo-Malayan region. Although it grows to a length of about two feet, it cannot compare in size to the American tarpons which can exceed eight feet, and have reached a record weight of 383 pounds. The world's record on hook and line is a 7 foot 2 3/5 inch fish, weighing 283 pounds, caught by M. Salazar in Lake Maracaibo, Venezuela, in 1956.

Salt or Freshwater

The tarpon is one of the few fishes with the amazing facility of being equally at home in freshwater or salt. Young tarpon have survived direct transfer from seawater to freshwater and back again.

Tarpon have a greater distribution in the Atlantic than most people realize. They occur along the entire tropical and sub-tropical east coast of the Americas, in the West Indies and are common on the tropical west coast of Africa. There are reports that they have gone through the Panama Canal and have become established in the

THE MIGHTY LEAP *of the tarpon. Large tarpon are reported, when hooked, to jump as high as twelve feet in the air, and to cover a horizontal distance of 25 feet. (Copyright photograph by Erl Roman. Reproduced with permission.)*

Pacific. They have twice been recorded as far north as Nova Scotia.

Sensitive to Cold

Tarpon are sensitive to cold and are usually among those fishes killed in shallow water areas when a severe cold wave strikes the southeastern United States. Temperature tolerance experiments at The Marine Laboratory of the University of Miami revealed that the limits which young tarpon can withstand are about 64 and 104 degrees Fahrenheit. These experiments were performed in September,

1957, following capture of the fish in shallow ponds in the Florida Keys where temperatures reached 98 degrees during the day. When kept in a cooler, shaded tank at the laboratory for two weeks the little fish acclimatized and were able to survive 55 degrees.

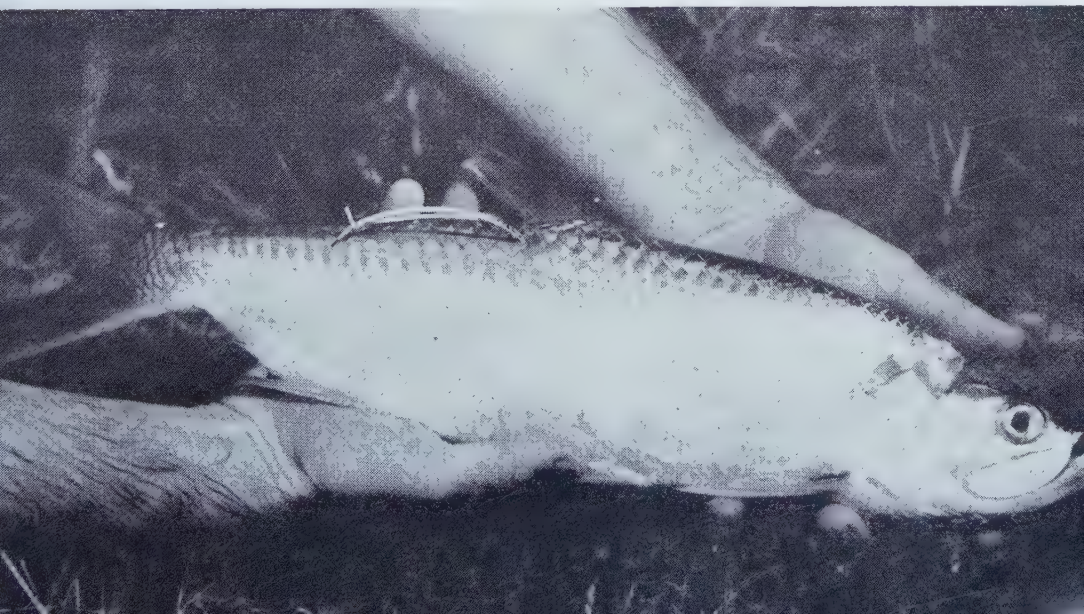
Nova Scotia Strays?

Exact movements of the tarpon are not known, but it is generally believed that extensive migrations are undertaken. Certainly those that were caught off Nova Scotia did not remain in these waters throughout the year. They must have swum there from hundreds of miles to the south during the warmer months of the year and therefore evidently are strays.

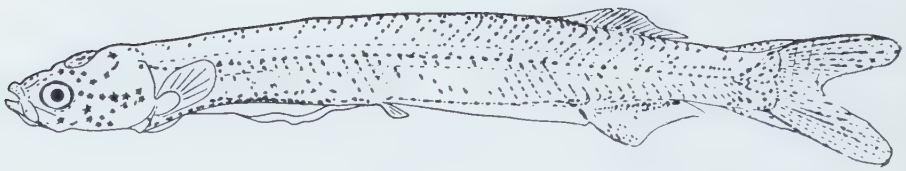
The marine biologist is more concerned with the movements of the main bulk of a fish population. Along the Gulf of Mexico coast, tarpon supposedly undertake a northerly migration during the warm months and move southward when the waters begin to cool. They are said to arrive in considerable numbers at Aransas Pass, Texas, about March, and appear along the Louisiana coast early in May, where they remain until October.

Disclosed by Freeze

During a January freeze many tarpon were killed in the Rio Grande. This came as a surprise to local inhabitants, who did not believe that they were present in the river at this time of year. It is possible that tarpon do not move great distances along the Gulf coast. With the advent of cold weather they may simply retire offshore to deeper water and enter a state of relative inactivity. As they return to activity with increasing temperature in the spring, they may return inshore to shallow waters. This would convey the impression of northerly movement, for those in the more northern localities would appear pro-



READY TO BE RETURNED *to the water. A young tarpon, wearing a spaghetti tag (which can be seen projecting from the fish's back near the dorsal fin) will henceforth do its bit for science. This tag, which does not harm the fish, consists of a loop of flexible plastic, threaded through the back. (Walter R. Courtenay)*



SMALLEST TARPON. *Game fishermen seek the biggest fish they can land. Marine biologists also find the tiny ones of interest. This three-quarters of an inch long leptocephalus larva of the tarpon (after Harringston) is the smallest on record. Scientists are still searching for earlier stages in the life history of the tarpon.*

gressively later in the year.

This speculation is not intended to deny the existence of long migrations, but merely to emphasize that such migrations remain to be proved. Certainly there are many well-informed persons who believe that extensive movements of tarpon do take place. Louis L. Babcock wrote in his delightful book entitled "The Tarpon":

"While there are always a few along the coast to the Gulf, the large apparently migrating schools disappear. For instance, they pass Boca Grande in uncounted thousands and never return until the next season. Where do they come from, and where do they go? Here is another mystery."

Difficult to Tag

The best way to follow the movements of fishes is to tag them. This has been attempted for the tarpon, but many difficulties were met. From 1938 to 1942, Charles M. Breder supervised a study of tarpon in the vicinity of Boca Grande, Florida. Strap and button tags were affixed to 480 fish. Only 21 were recovered, eight of these from enclosed areas where migrations were not possible. The longest period during which a fish retained its tag in open waters was six months. The tagged fish moved various distances from two to 19 miles. Naturally nc sweeping conclusions can be made from so few recoveries, but they certainly are not suggestive of long migrations.

A tagging program was initiated at The Marine Laboratory of the University of Miami, beginning in May, 1955 as part of a broad study of the biology of the tarpon which has been generously supported by Foundation member Mr. Roger Firestone and the Florida State Board of Conservation.

Not Taken Commercially

Results of this tagging have been disappointing. Only one fish was recovered out of 131 adults to which dart or strap tags were fastened, and this fish was in the process of losing its dart tag. It held the tag nine months and moved ten miles from the point of tagging.

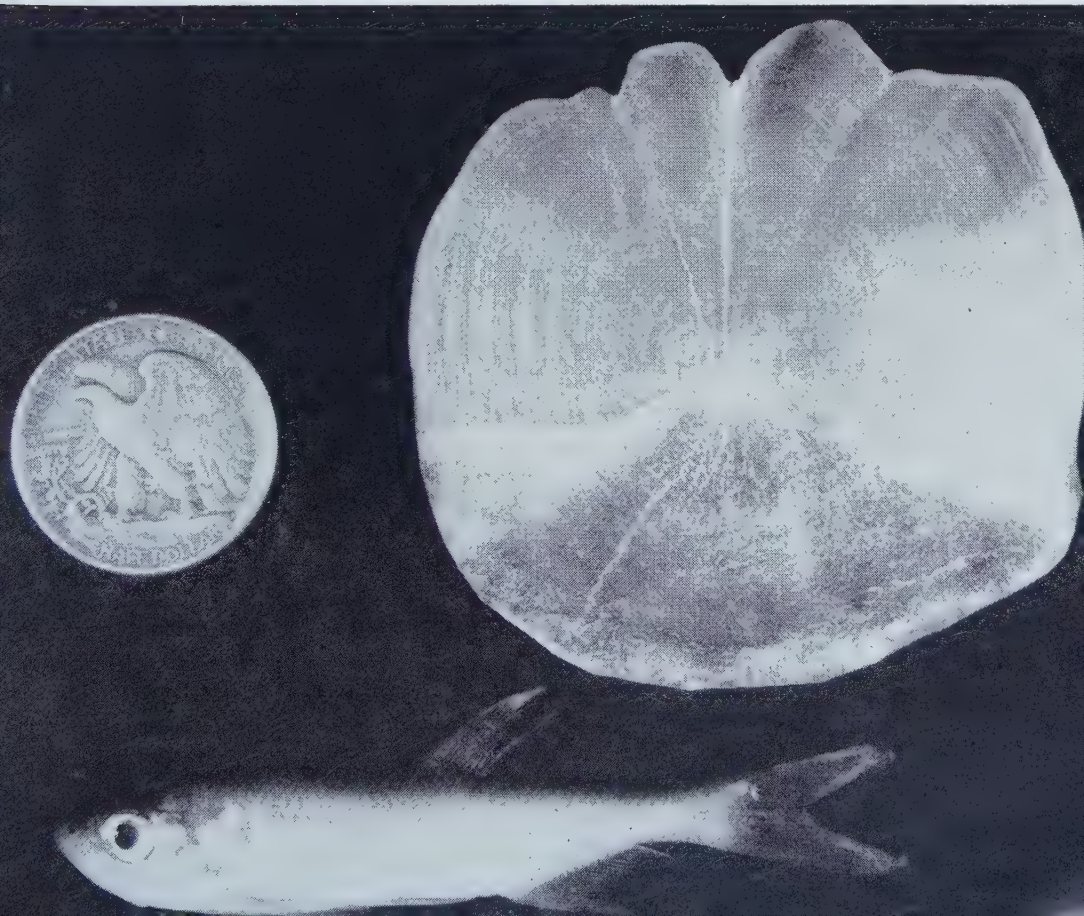
A number of factors make the tarpon a most difficult species to tag successfully. It is not taken commercially. Thus there is no large quantity available at any time for the biologist, who must either devise some means of taking the fish himself or resort to assistance from individual fishermen or fishing guides.

The tarpon has also demonstrated itself as a poor subject for tag retention. Furthermore its large size and strength (and heavy scales) make the task of tagging laborious and time consuming. Undoubtedly many fish die or are killed by sharks when, following their terrific struggle on hook and line, they are finally tagged and released. Another problem arises from the failure of fishermen to notice the tag. As a conservation measure, most tarpon are released by sportsmen without being boated, and undoubtedly some tags have been overlooked, especially since much tarpon fishing is done at night.

Yellow for Visibility

In spite of all these difficulties, tagging efforts will be resumed. A new type of tag for tarpon is now being tested. This is the so-called "spaghetti tag" which has been so successfully used on tuna in the Pacific. Albacore swam all the way from California waters to Japan and Midway bearing such tags.

The tag consists of a loop of soft plastic and is usually threaded through the back, the two ends knotted or



THE SCALE OF A SIX-FOOT TARPON *(right) makes an interesting contrast with a four-inch juvenile, and a half a dollar coin. Some fishing lodges, clubs, and restaurants, where tarpon fishermen gather, have their walls covered with tarpon scales, duly marked as to place, date, size and name of the angler.*

clamped with a monel band. The tags are colored yellow for maximum visibility and bear the inscription "Reward for fish, Marine Lab., U. of Miami" and a number.

One three-foot tarpon, experimentally tagged in a pond near the laboratory with one of these tags on the back behind the dorsal fin, is retaining the tag well after a period of five months. Recently three men spent an entire afternoon trying to net this fish in order to measure it and obtain a scale sample. Whenever surrounded with the seine, the tarpon contemptuously leaped over the float line.

Anglers Beware!

In addition to data on movements, tag recoveries should provide valuable information on growth, but no reliable data were secured from any of the recoveries of tagged tarpon mentioned above. The previous tagging programs enlisted the aid of fishermen and guides and no accurate measurements were obtained both at the time of tagging and at recapture of a fish.

In all fairness, however, it should be pointed out that it is not easy to make an accurate length measurement of a wriggling, fighting tarpon in a small boat. If the fish is very large, it involves real danger. There are at least seven recorded instances of people killed outright, or knocked overboard and drowned, by tarpon.

Some data on growth have been obtained by Breder from three tarpon raised in the old New York Aquarium. They grew from less than 20 inches up to 50 inches in five years. Information on growth of fish held in aquaria may be considerably different from natural growth because food habits may be altered. Growth may also be affected by their confinement. Probably the most important condition is the temperature, if this is different from that of the normal environment. Certainly an effect would be expected due to uniform temperature throughout the year in the aquarium. In nature, at least for American tarpon, there is a marked annual variation in temperature and probably little or no winter growth.

Scales as Age Indicators

Scales of many fishes, especially those in regions where there is a distinct cold season, may be used for estimating age and growth. Scales grow in successive stages by marginal additions, which result in fine concentric ridges known as circuli. During winter, when growth ceases, an obvious gap in the circuli may result. This is called an annulus.

Thus the age of a fish can be determined by counting the annuli as one would the growth rings of a tree which appear in a cross-section of its trunk. By measuring the lengths of many fish, and tabulating these lengths by age groups, an estimate of growth may be obtained.

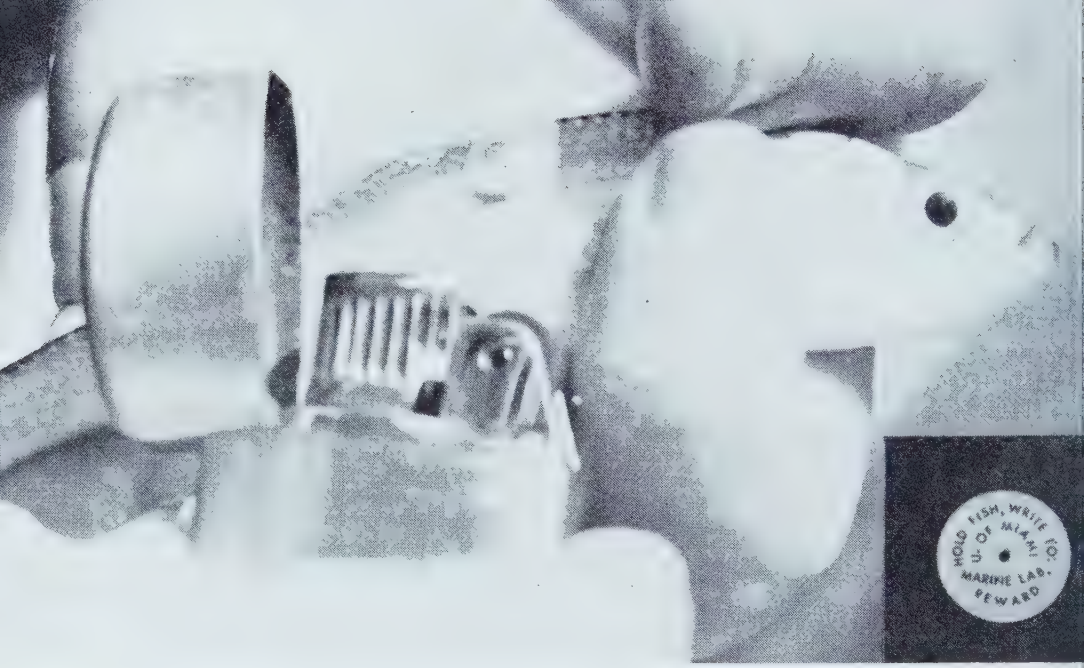
Tarpon scales contain what appear to be annuli. Breder read the scales of 59 tarpon and Marine Laboratory personnel those of 181 fish. The results are similar and the growth as computed is almost identical to that of the aquarium fish. Scales were found with as many as 16 annuli. Growth of fish with ten or more annuli seems to be about 2½ inches a year.

Until growth from reading the scales is confirmed by data from tagging, or by demonstration that only a single annular mark is formed on the scales each year, the rate of growth given above is regarded as purely an estimate. It is possible, for example, that tarpon cease to feed during spawning time, resulting in a mark on the scales similar to an annulus.

The spawning season for tarpon is not positively delimited. Babcock wrote, "The indications are that the time of spawning on the West Coast of Florida is from late June to September." Breder stated that tarpon spawn in west Florida, ". . . during May, June, and July at least." Spawning is believed to take place in inshore waters, and some persons claim to have witnessed it.

Like most fishes with pelagic (open sea) eggs, the tarpon has an enormous potential. The ichthyologist J. T. Nichols once estimated (by counting the eggs in one ounce of an 83 ounce ovary) the number of eggs in

A NYLON THROW NET *is an effective means of collecting baby tarpon in rock-strewn waterways, such as this one on Lower Matecumbe Key, Florida. University of Miami student, Walter Starck, demonstrates the proper technique. These ponds are sometimes nearly landlocked; only through adjacent pools is there a connection with the sea. (Terry Starck)*



TAGGING A JUVENILE *tarpon with Petersen disk tags. Small disks are joined through the back with monofilament nylon. The cigarette lighter is used to melt the ends of the nylon into little knobs to keep the disks in place. Insert (right) shows inscription on cellulose acetate tag. (Walter R. Courtenay)*

a 142 pound tarpon to be over 12 million.

Ribbon-Like Larva

Recently in Florida a late larval stage of the tarpon was discovered. It is three-fourths of an inch long, ribbon-like, and glassy transparent. This type of larva has been found also for that close relative of the tarpon, the ox eye, as well as some other primitive teleosts, such as the ten pounder or lady fish, the bone fish, and eels. This larva is so different from the adult fish that it was originally given the generic name of *Leptocephalus* in the belief that it represented a distinct group of fishes. It has been difficult to link the leptocephalus of the various species to known adult fishes. One of the main reasons for this is the shrinkage which the leptocephalus undergoes when it transforms from the larval form in the plankton to the juvenile state inshore.

Breder tried to obtain ripe female and male tarpon on hook and line in order to attempt artificial fertilization of the eggs. He found males with ripe sperm relatively easy to procure, but caught no ripe females. He therefore assumed that ripe females either will not take a bait or, if they do, the eggs are shed because of the violent body contortions during the fishes' struggle.

Resists Experiments

He then decided to confine adult tarpon approaching spawning condition in an enclosure eight feet square and five feet deep. Instead of the eggs ripening in the normal way, they were absorbed within the bodies of the females. His next effort was to try to find tarpon eggs drifting in the shallow water. Nets were towed where adult

tarpon had been observed milling around. Eggs of about the right size were taken near the bottom and an attempt made to rear them in the laboratory; however all the larvae died at the age of 72 hours after hatching, in a stage of development too early to be identified positively as tarpon.

At The Marine Laboratory a plan has been devised to hold adult tarpon in a large pond which can be readily seined. During the next spawning season the tarpon will be captured repeatedly in the hope of securing ripe fish for artificial fertilization of the eggs.

Young Fish an Event

Until recently the life history of the tarpon presented an anomaly, namely the presence of a fairly large number of adults but only scarce and scattered records of the young. Indeed, the mere finding of small tarpon has been regarded of sufficient importance to warrant scientific publication. On September 4, 1957, 59 baby tarpon, 1½ to 6 inches in length were seined by the authors from a brackish pond on Lower Matecumbe Key in the Florida Keys and later other collections were made in this and adjacent pools. In some of these, the bottom was so rocky, or contained so much brush, that a seine could not be used; however a cast net often proved usable.

The pond where the little tarpon were collected is nearly land-locked; only through adjacent pools is there a connection with the sea. There is a mud bottom and the water is brown and somewhat foul. Upon checking other records of small tarpon, it was found that nearly all have been taken in a similiar unsavory environment. Sometimes they have been found in completely land-locked pools.

Upon seining 36 two to eight inch tarpon from a pool on Haiti, William Beebe wrote of his astonishment "at seeing these clean-scaled, virile fish living in this sulphurous, stagnant pool." Possibly this sort of habitat is the normal one for young tarpon, which would explain why so few have been collected.

"Rolling" for Air

Tarpon have a lung-like air bladder, and when they "roll" at the surface they take in atmosphere air. This enables them to survive in waters of low oxygen content, such as stagnant ponds, where most fishes would perish. Undoubtedly, baby tarpon leave many predators behind when they enter such ponds. But many animals that would constitute food for them are also left behind because of the harsh environment. Few organisms can tolerate low oxygen content, presence of hydrogen sulfide, and great changes in temperature and salinity that may occur in the ponds.

Adult tarpon prey upon a variety of aquatic animal life, such as mullet, pinfish, bream, needlefish, crabs, and shrimp. Almost nothing was known of the food habits of juvenile tarpon until the stomach contents of some of those from the Matecumbe ponds were examined.

Surprisingly, the small tarpon up to about 3½ inches in length proved to be plankton feeders. Their stomachs were packed with copepods of the genus *Cyclops*. Nearly 4,000 of these tiny crustaceans were contained with-

in the stomach of one juvenile fish. Tarpon have from 58 to 62 gill rakers on each gill arch with which they strain the small animal plankton from the water. Slightly larger fish, although still feeding on copepods, also ate crab larvae and aquatic insects, indicating a seeking out of individual prey. At a still larger size fish becomes the dominant food. One eight-inch tarpon was found with a three-inch tarpon in its stomach.

Graphs made from repeated collections in the ponds indicate the rate of growth of the Matecumbe population of juvenile tarpon. In order to confirm the growth estimates, seventy little tarpon were tagged with Petersen disk tags and released in the ponds. Thirty-one of the tagged fish were recovered. Their growth of four-tenths of an inch per week proved to be comparable to the estimate from the graphs.

Another population of tarpon, these averaging 14 inches in length, was found in a drainage ditch near Goulds, Florida, on August 22, 1957. Thirty were caught by seining and tagged with disk tags. Two months later nineteen were caught, of which five bore tags. Measurements show these fish grew at an average rate of three-tenths of an inch per week, only slightly less than the smaller Matecumbe tarpon.

Tarpon without tags were tagged before release. On November 22, eleven were caught, three with tags. The growth of these had slowed to .05 inches a week. From late October to December 9, the Matecumbe tarpon grew only .02 inches per week.

Cold Wave Ends Experiment

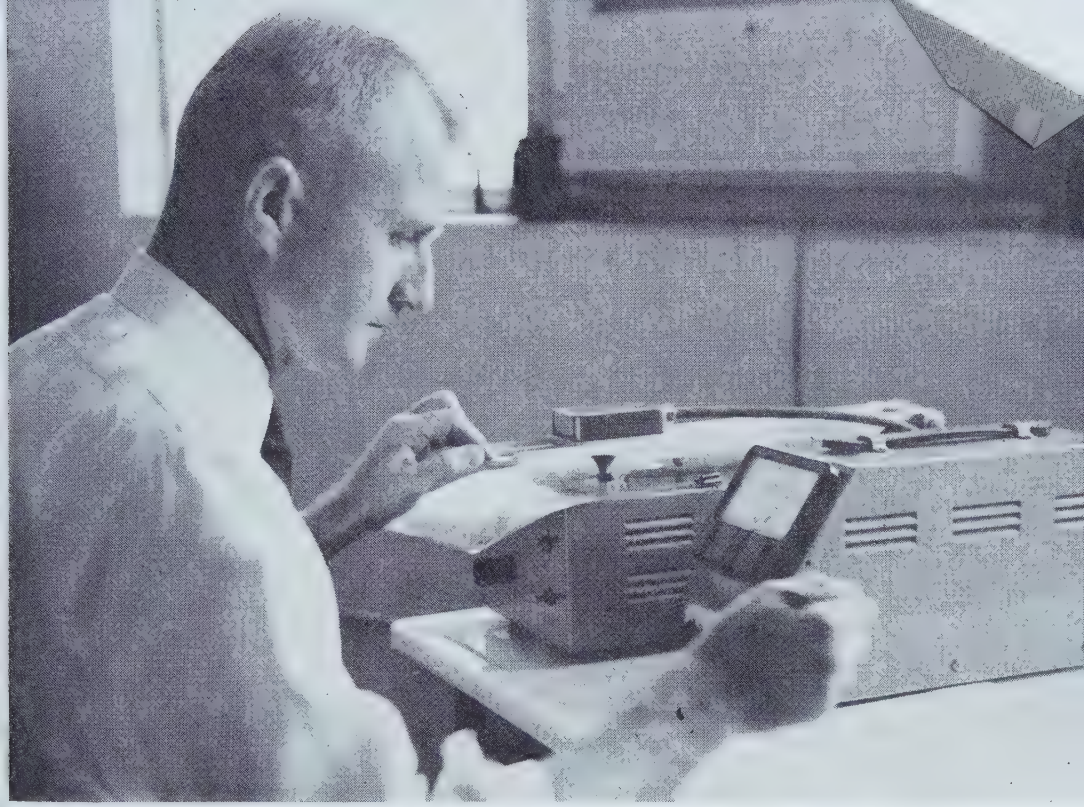
Beginning December 11, 1957, Florida experienced its worst cold snap in many years. Fishes were found dead in shallow waters throughout the State, among them tarpon. The cold spell temporarily put an end to the tarpon growth-study of The Marine Laboratory. On Lower Matecumbe Key only two small tarpon could be found, where perhaps two hundred had been before.

The entire population in the drainage ditch near Goulds disappeared. Thirty-six were found dead on the banks, of which twelve had been tagged. None of the fish measured in November had increased at all; thus it seems likely that the growth of the tarpon ceases during the cold months of the year.

The tarpon, as the record shows, is proving to be an extremely difficult fish from which to extract accurate biological information. Nevertheless, the prospect is not as bleak as it may appear. Determined research will continue and new studies will be launched.

Doldrums and Horse Latitudes

The doldrums are stretches of ocean, between the trade wind belts, where the air is quiet and sultry. Cyclones and frequent squalls originate there. The horse latitudes, calms near the Tropics of Cancer and Capricorn, are regions of very light, variable winds.



MEET THE PHOTO-ELECTRONIC DENSITOMETER, *here being operated by the author. Through the use of this instrument the densities of radar echoes, reflected from the raindrops in a storm, can be read on a grid system. Contours can be traced to match the echo densities with actual field reports of rainfall. (Max Hunn)*

Radar Estimates Rainfall

By HOMER W. HISER

YACHTSMEN and other mariners depend upon radar for navigation at night, or at any time in foul weather. Now this nautical "seeing eye" can be used to estimate the amount of rainfall occurring over large areas.

Ever since the end of World War II, when radar's security wraps were removed, several research groups have investigated the use of radar as a rainfall yardstick. One of these studies has been carried out by The Marine Laboratory of the University of Miami.

Under the sponsorship of the U. S. Weather Bureau, this group has explored various methods of estimating flood-producing rains through the use of integrated or time-exposed photographs, taken by means of radar. The results are expected to be of great practical value in flood forecasting, drainage control, traffic movements, emergency power requirements, and for other purposes.

CONSTANTLY SWEEPING THE HORIZON, *this radar antenna on top of the Merrick Building, University of Miami, now has a new role as it tracks rainfall occurring over large areas, enabling Weather Bureau experts to estimate flood-producing rains. It is impossible to have sufficient rain gauges and speedy reports from them when they are located in remote areas where floods often originate, but radar is continuous and instantaneous. Marine scientists are interested, too, because so many factors affecting rainfall and the weather originate at sea. (University of Miami)*

Marine Scientists Interested

Marine scientists are also interested in this expansion of radar's role because so many factors affecting rainfall and the weather originate at sea. The ocean breeds, too, such disastrous storms as hurricanes and typhoons. Radar has already proved valuable in tracking such disturbances, but until recently there has been no accurate way of determining how

much rainfall a storm produces over wide expanses of remote areas where floods often originate. In other words, it is impossible to have sufficient rain gauges and speedy reports from them in such areas—but radar is continuous and instantaneous.

Scientific data and findings are now available from radar experiments conducted in 1955-57. During a three-hour period of photo-integration on February 27, 1957, for instance, a total area of 31,500 square miles in southern Florida was observed. Rain was falling in about a third of the area. Rain gauges, located in various places within the region studied, were checked and readings noted, in order to obtain data that later could be cross-checked against the radar photo-integrations.

How Does It Work?

How is the rainfall seen and recorded by radar? Like any other object that blocks the radar beam, falling raindrops cause the radar impulses to "bounce back." They show up on the radarscope as glowing light patches, the intensity varying with the amount and spread of the rainfall. Special integrator cameras, placed before the radarscopes, make a continuous record of the radar echoes. By using a grid that indicates the location of rain gauge stations, and noting time intervals, location and intensity of storms as recorded on film are analyzed and rainfall estimates made.

Will Not Supplant Rain Gauges

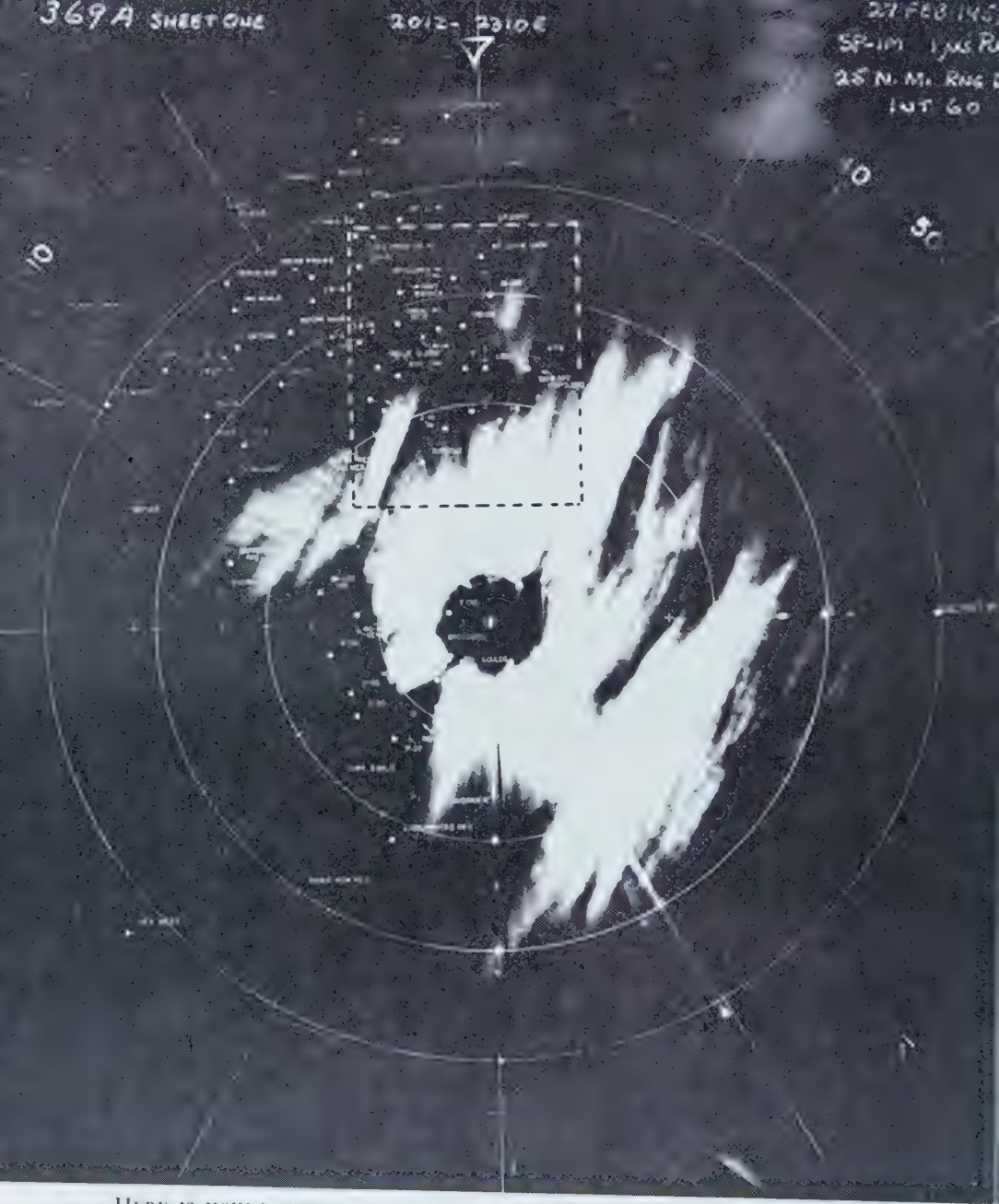
Ultimately, two or three gauge readings of rainfall amounts, received by telephone or radio, will be employed as a key to assigning rainfall values to the radar echoes. Thus radar photo techniques will not replace the rain gauge network, but will be used to supplement it by covering blank areas between gauges, and by giving immediate information regarding areas where few rain gauges exist, or where most of the rainfall reports are delayed.

What kind of equipment is needed? High-powered, 10-cm wave length radars, such as the U. S. Navy model SP-1M used in this research, are recommended. A basket-type antenna radiates high frequency signals in a conical-shaped beam which constantly sweeps the horizon.

The Integrator Cameras

The special integrator cameras that record the radar data as it appears on the radarscope are simple in construction. For photography fans, the following details will be of interest: f-4.5 lens, a 45-degree front surface mirror, and a standard 8 x 10 inch film holder. The lens aperature is ordinarily set at f-4.5, and the shutter is left open. Integrated photographs are made by time-exposing film to the model VD-2 radarscope repeaters for periods of from one to six hours.

As for film, Kodak fine grain positive has been found to be the most satisfactory. The area near the radar is void of rain echoes because a special device is used to eliminate those at short ranges. Reflections from ground targets in the vicinity of the radar renders this sector useless for integration, and complete removal of the echoes prevents halation of the film in the immediate surroundings.



HERE IS HOW RAINFALL IS SEEN BY RADAR. *Like any other object that blocks the radar beam, falling raindrops cause the radar impulses to "bounce back." They show up on the radarscope as glowing light patches, the intensity varying with the amount and spread of the rainfall. Special integrator cameras, placed before the radarscopes, make a continuous record of the radar echoes. By using a grid that indicates the location of rain gauge stations, and noting time intervals, location and intensity of storms as recorded on film are analyzed and rainfall estimates made. This integrated radarscope photograph shows rainfall in the vicinity of Miami on February 27, 1957. (University of Miami)*

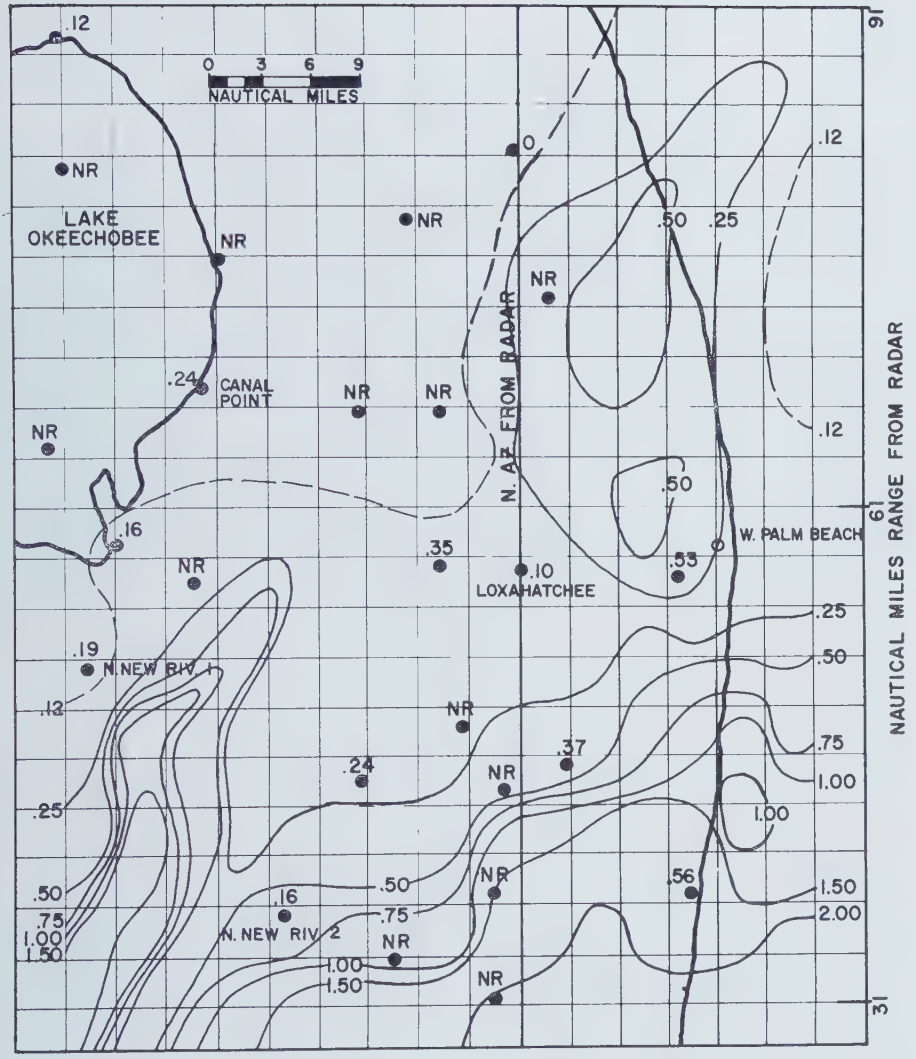


CHART COMPARING ACTUAL RAINFALL *with the estimated rainfall as measured by radar equipment. This "iso-echo density" map was constructed from values obtained by the use of an instrument called a photo-electronic densitometer, probing a storm area between Lake Okeechobee and the Atlantic coast of Florida near West Palm Beach. The date was February 27, 1957. The lines join places with equal rainfall as estimated from radar echoes, the amount being shown in inches for each line. The heavy dots mark rain gauges, with the actual rainfall shown by adjacent numbers.*

Reading Echo Densities

In the typical radarscope photo-integration, shown on page 150, the dots indicate the locations of rain gauges used to obtain data for correlation purposes. Density of echoes appearing on the radarscope, corresponding to a given place, reveal rainfall intensity and duration, because radar energy is reflected from the raindrops in a storm.

The densities of the echoes are read on a grid system by the use of an instrument called a photo-electronic densitometer. The values obtained in this manner are then used to construct an "iso-echo density" map, on which contours can be traced to match echo density with actual field reports of rainfall.

Even in the present state of development of the photo-integration technique, the lines of constant radar echo density show the rainfall pattern reasonably well. However, equal densities at different ranges do not represent equal rainfall amounts, due to dispersion loss of the radar energy during its two-way travel.

Problems Still Ahead

Therefore, storms of a given size and intensity receive and return more signals at short ranges than do similar storms at greater ranges. Also, the radar looks over the top of large portions of most storms at ranges greater than 150-175 nautical miles, because of the earth's curvature and the nearly line-of-sight course of radar signals.

Research will continue on this problem of presenting storms of like intensity in an equal fashion, at least out to ranges of 150-175 miles. This and other refinements can be expected in the photo-integration method of estimating rainfall by radar. Present meteorological radars are already providing other weather information. Rainfall estimation will be another task and will increase their utility.

Shells As Money

From time immemorial, shells of the cowrie, a handsomely housed gastropod or sea snail of the Indian and Pacific Oceans, have been among the most widely distributed forms of money. Even after gold, silver, and bronze coins came into use, cowries served as common currency throughout a vast expanse of the trading world. The Atlantic cowries, of a different species, were not used as currency.

Rock Once Listed As "Man-o'-war"!

Diamond Rock, a small steep island off the coast of Martinique, was at one time listed by the British Admiralty as a "man-o'-war." The reason for this lies in the fact that British officers and sailors hauled big guns up its sides and defended it against the French in 1803.

LAMINARIA STIPES *are loaded into trucks as if they were farm produce. The stalk of this seaweed, washed up in the Western Isles of Scotland in winter, yields especially rich gels. Alginate jelly can be used for preserving many kinds of seafood, from shrimps to whale meat. (Alginate Industries Ltd., of London)*

Algin, Gift of Seaweed

By DR. LILY NEWTON
University College of Wales

SOLVERS of crossword puzzles are probably quite familiar with "algin." Others possibly may be surprised to learn that it is the most important part of the cell wall of the larger brown algae, or seaweed.

Algin is commercially the most valuable extract from seaweed, and makes up from 14 to 40 per cent of the dry weight of the larger kelps and rockweeds. These plants of the sea vary in different parts of the world, but all are spectacular in form, whether their fronds float up, sometimes breaking the surface of the water, from deeply attached holdfasts, or whether they fringe rocky shores and are tossed to and fro with the advancing or receding tides.

Tool of Textile Trade

Algin is similar to cellulose, the chief component of wood, and pectic acid, which is found in plant tissues. It is insoluble, but it forms salts, of which the sodium, potassium, lithium, magnesium and ammonium alginates are soluble. When soluble, the salts are readily and quickly dissolved in water with the aid of high-speed stirrers. This is of great importance

KELP BEDS *give the sea an oily, unkempt look as golden fronds of* Macrocystis pyrifera *float up to the surface in masses along the rocky Tasmanian coast. The fronds are strong, and firmly anchored to the bottom by large holdfasts. (Alan B. Cribb)*

in some trades, such as textiles, where the alginate is a tool in a process, and needs to be washed out after use.

Commercially, alginates are produced by a number of countries, from a variety of seaweeds. One of the most important producers is the United States, where Macrocystis is harvested from the Pacific, and Laminaria sp. from the Atlantic coasts.

Important recent work on Macrocystis has been carried out by Australian workers. Womersley has outlined the distribution of the genus, showing that it is plentiful round most islands in the region and extends almost up to the equator in South America. In the northern hemisphere the genus occurs only off the west coast of America, from about Magdalena Bay (California) to near Sitka in Alaska.

Studies off Tasmania

In view of the occurrence of rich beds off the Australian and Tasmanian coasts, Cribb, has made an extensive study of *M. pyrifera,* near Port Arthur. In that locality the golden fronds of Macrocystis, mottled like crepe rubber, float up in masses from their enormous, deeply-attached branched holdfasts and give the water a smooth, almost oily appearance.

The fronds are so strong and so firmly anchored by large holdfasts that the boat of the investigator is easily anchored by twisting a handful of fronds round a convenient projection.

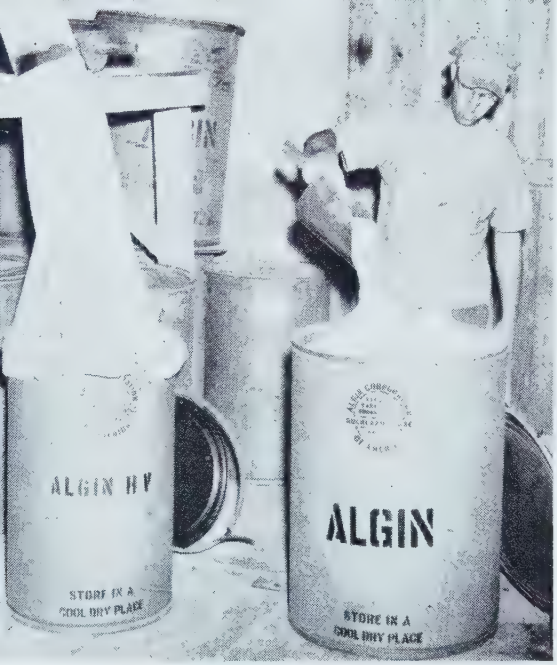
Although little if any seaweed processing is done in Canada, harvesting takes place there, and important surveys have recently been made by MacFarlane, in southwest Nova Scotia, with a view to increasing the Laminaria and Ascophyllum harvests. These weeds are exported to America for extraction. Several findings emerge from recent American and Canadian work. MacFarlane has shown that in harvesting Ascophyllum, not less than 6 or 7 inches should be left uncut and the beds should not be harvested again for three years. This is in accord with observations made in Wales.

Laminaria at Low Tide

In Britain where Laminaria and Ascophyllum are both used as sources of algin, *Laminaria Cloustoni* is of especial importance. This alga is a particularly dramatic sight at low water, when the bases of the expanded fronds stand above the surface and roll in the tide.

Although difference in the rigidity of a jelly will depend partly on the

ON A TASMANIAN BEACH, *when viewed close-up, the stipes of Macrocystis look like a telephone switchboard blown inside out. So powerful are the holdfasts of this species of seaweed that boats may be safely moored to them. (Alan B. Cribb)*



AND NOW THE FINAL PRODUCT. *Much processing has preceded the fine white powder, odorless and tasteless, that pours into large waterproof containers for shipment to the food and bakery trades, as well as manufacturers of cosmetics, textiles, paper, paint and drugs. (Algin Corporation of America)*

concentration of the alginate, it is also dependent on the plant from which it was obtained. The stipe or stalk of *L. Cloustoni* yields especially rich gels, which is one reason for the importance of the huge casts of stipe that wash up in the Hebrides in winter. Ascophyllum gel is much less rigid, but it has its uses in industry where semi-gels are needed or where extensible films are being produced.

In France the algin industry is small, but Laminaria is mainly used by three factories: two in Finistere and one in the Côtes-du-Nord. In Japan, *Ecklonia cava, Eisenia bicyclis* and some Laminaria and Sargassum species are regarded as yielders of alginic acid, and potential producers of sodium alginate, the total annual yield being about 430 tons. It is used mainly as dressing for textiles, for sizing paper, in the food trade and for medicine.

Used For Food in Japan

While it is recognized that Laminarias yield the highest grade of alginate, these plants are generally used for food in Japan and are therefore too high priced to be used for alginate production. The cost of Sargassum weeds, many of which are elongated and easily obtained, is low but so are their algin yields. In addition, the alginate is regarded as of inferior quality, both in viscosity and in color, since bleaching is difficult. Ecklonia and Eisenia are widely distributed in Japan, except in the Hokkaido region, and the per cent yield of alginic acid is not very different from that of Laminaria. They are said to be the principal source of Japanese alginate.

In Chile some attempt has been made to harvest *Durvillea antarctica* and *Lessonia nigrescens* for alginate production. Durvillea is a very handsome alga when its huge stipes fringe rocky ledges, and the fronds are swept to and fro with each successive wave.

Norway's Production

Norway, with its enormous coastline, has paid considerable attention to its algal resources in recent years, both from the point of view of survey and alginate production. Grenager and Baardseth have published very substantial papers on the distribution and the ecology of the Laminaria and Ascophyllum. Two firms manufacture alginates. Although *L. Cloustoni* is

the dominant species round Norwegian Coasts, it does not appear to be harvested commercially.

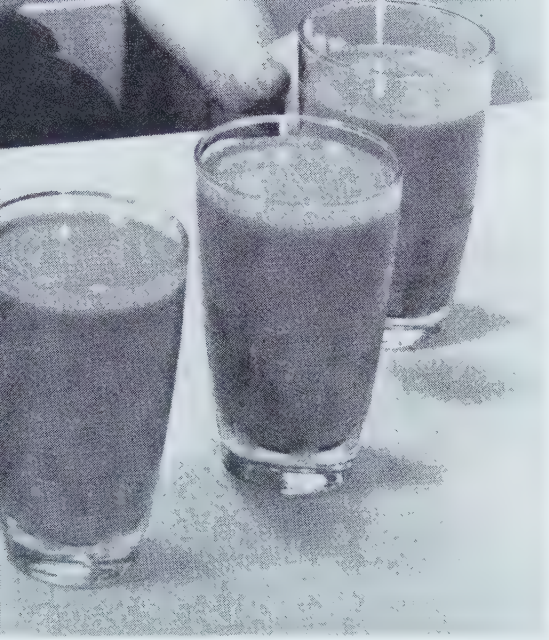
Taken as a whole, world alginic acid production amounts to over 1,000 tons annually and the substance is finding an ever-expanding use in industry. The alginate radicle is non-toxic and therefore alginates are edible, if they are combined with suitable bases. There is some evidence that sodium alginate and propylene glycol alginate can form part of the carbohydrate of the diet. Normally, however, much of an alginate remains undigested. It can, in fact, act as a bulk laxative. These facts enable alginates to be used increasingly in the food and bakery trades, as well as in the manufacture of cosmetics, in the textile, leather, paper, paint and ceramics trades, in the stabilization of creamed rubber latex and in the making of soluble films.

Preserves Fatty Fish

Recent important developments are the rapidly increasing use of algin in the fish trade, both in the preservation of fatty fish, which can be embedded in an alginate solution before freezing, and also as a means of keeping a preservative, such as aureomycin, evenly distributed in ice when trawlers are at sea. A soft jelly which is quickly washed out after thawing can also be used for preserving shrimps. During the last whaling season, whale meat was successfully frozen in alginate jelly.

Alginates are also taking a more

RESEMBLES CREPE RUBBER, *but it is seaweed. A workman inspects the heavy kelp* (Macrocystis pyrifera) *which grows so abundantly near Port Arthur, Tasmania. The knife on a pole is used to cut the well-anchored seeweed from its holdfasts on the sea bottom. (Alan B. Cribb)*



EVER WONDER WHY *the cocoa in chocolate milk does not sink to the bottom of the glass? The answer is alginates, or one of the similar derivatives of seaweed. Algin suspends the cocoa particles uniformly, so that the drink may be processed in either powdered or syrup form. (Borden Company)*

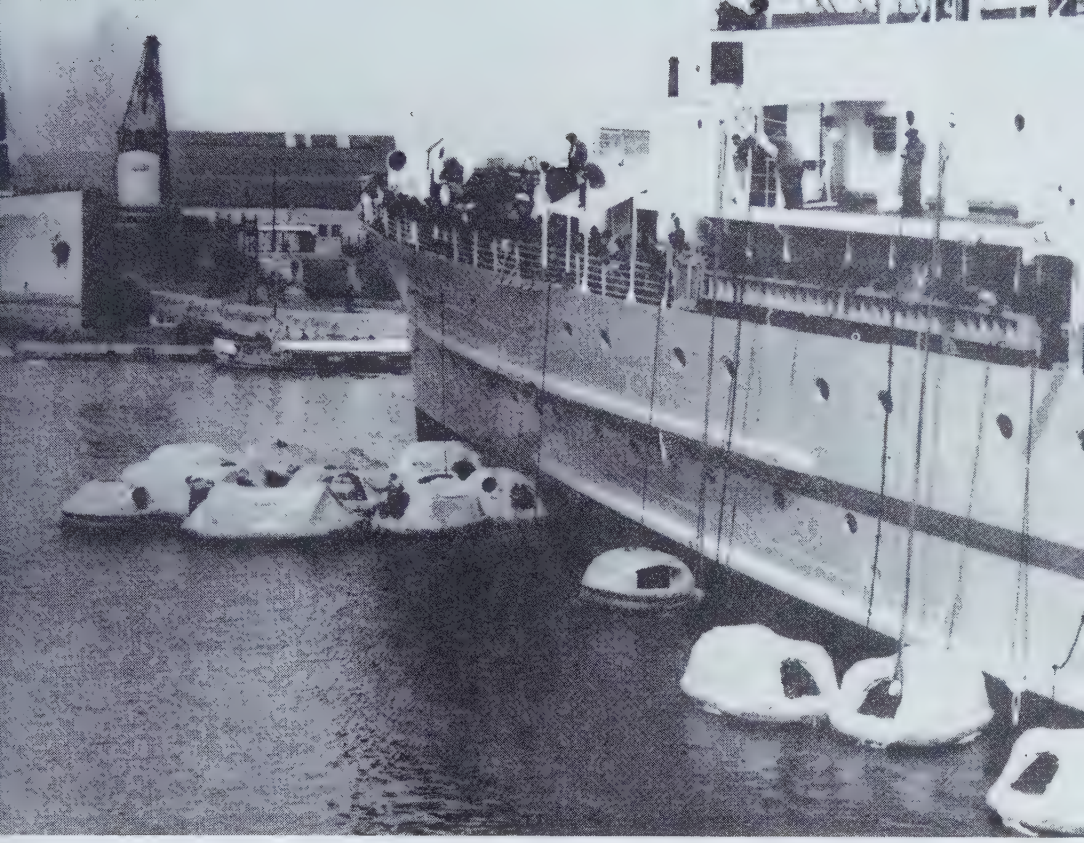
important place in clinical surgery. Calcium alginate wool is used as a swab, it is completely soluble and yields a viscous solution in which the bacteria contained in the swab are suspended and can be diluted. Percentage recoveries of *Staphylococcus aureus* gave a mean value of 90.7% as against 49.9% for cotton wool. *B. coli* gave a mean of 89.9% as against 67.0% for cotton wool.

Aid To Physicians

Absorbable calcium alginate wool has also proved of great value in surgery, where it can be absorbed by the body without harmful effects, and it has a local haemostatic effect as well. If some of the calcium ions are replaced by sodium ions, the rate of absorption can be increased. It is compatible with penicillin and can thus be used to prevent post-extraction haemorrhage in dentistry with great success. It is heat resistant and can be easily sterilized.

When used as a dressing, in the form of a loosely knitted gauze, calcium alginate not only arrests bleeding but provides a mesh in which the blood rapidly clots. Haemostasis may be accelerated by the release of calcium ions by the blood itself. A gelatine-like film is formed which protects the wound. The remaining calcium alginate material is readily dissolved in a solution of sodium bicarbonate, so that delicate tissues, newly formed, are not torn, neither is the patient disturbed by the painful removal of a dressing. Healing is more rapid, to the benefit of both nurse and patient.

Research now taking place will undoubtedly reveal many more uses for this versatile extract—one of the many valuable gifts from the sea.



MASS LAUNCHING TRIAL. *In all, fifteen rafts took part in this demonstration from a British passenger ferryboat. When not in use, the rafts are contained in a canvas valise. In an emergency, the valise, with raft, is pitched overboard, first securing the end of its 60-foot nylon cord to the ship's rail. The cord trips the valise, causing the raft to burst forth. Carbon dioxide inflates two bouyancy chambers, all in a matter of seconds. (Cory Brothers & Co., Ltd.)*

Snug as a Shipwrecked Bug!

By P. R. ANDERSON

EDITOR'S NOTE

A photograph of a British jet fighter pilot in a new type of inflatable dinghy, published in the September, 1957, issue of *Sea Frontiers,* evoked so many comments that a request was sent to an English manufacturer of survival equipment for more information. The following article was written by Mr. P. R. Anderson, of Cory Brothers & Co., which company also provided the illustrations.

ONLY those who have experienced the hazards and terror of going over the side of a sinking ship in a conventional lifeboat, or the agony of being exposed to the elements on an open raft, can really appreciate the revolutionary changes in marine lifesaving equipment that have taken place in recent years.

Most people are aware that military aircraft for many years have carried inflatable rubber dinghies or rafts be-

cause they had no space for boats. They will remember, too, the valuable use made of them during World War II, and the heartening message often flashed back after an aircraft had been reported missing at sea: "dinghies sighted by search planes."

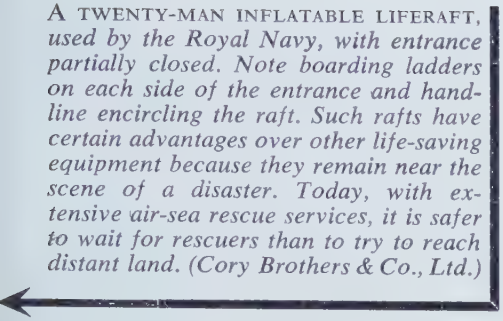
But it is not yet common knowledge that large-size, sheltered inflatable liferafts are being carried on a very high proportion of world shipping, including some of the largest passenger liners. This development is of interest and importance to oceanographers and others interested in marine activities, because it means that another type of craft is fulfilling a unique and specialized mission on the high seas.

Genesis of the Change-Over

The switch on large ships from metal and wooden lifeboats to inflatable types did not "just happen." It followed a thorough investigation made by the British Admiralty into war-time personnel losses, revealing that 70 per cent of lives lost in ship sinkings were caused by drowning or exposure after abandoning ship, whereas some 26,000 air force personnel had been saved by their inflatable dinghies.

As a result, the Elliott 20-man "Mariner" liferaft was adopted by the Royal Navy. Today not only naval vessels but many merchant ships are carrying inflatable rafts based on this design—a rubberized cotton material, incorporating a bottle of carbon dioxide gas which, when released, inflates the fabric into a seaworthy craft.

Here is how it works. In its stowed state, the raft is contained in a canvas valise, which serves also as protection against the weather when not in use. In an emergency, the valise, raft and all are pitched overboard, first securing the end of its 60-foot nylon cord to the ship's rail. The cord,



A TWENTY-MAN INFLATABLE LIFERAFT, *used by the Royal Navy, with entrance partially closed. Note boarding ladders on each side of the entrance and handline encircling the raft. Such rafts have certain advantages over other life-saving equipment because they remain near the scene of a disaster. Today, with extensive air-sea rescue services, it is safer to wait for rescuers than to try to reach distant land. (Cory Brothers & Co., Ltd.)*

when pulled, causes the raft to burst from its valise, the carbon dioxide valve to trip, and inflate two separate buoyancy chambers, all in a matter of seconds.

Advantages of New Device

What are the advantages of the inflatable liferaft over those of the ship's lifeboat, and an infinite number of other forms of buoyant apparatus?

First, no seamanship is required to handle the inflatable raft. Because it has a built-in sea anchor, the raft will always remain head-on to sea.

Second, all marine liferafts incorporate a self-erecting canopy. This canopy, further, is double-skinned, hence a layer of air stands between the elements and survivors, providing insulation between extreme heat and cold. The floor also is separately inflatable—in the tropics where cooling is necessary it may be left deflated; in the arctic regions, inflation offers vital insulation against cold.

Bounces off Obstructions

Third, when inflated the liferaft is rather like a ball. That is, it bounces off obstructions rather than is damaged by them. Under rough sea conditions, an inflatable liferaft can strike the side of a sinking ship without damage, in marked contrast to the ship's lifeboat, which might be stove in, or even sunk. A well known hazard is the risk of survivors being crushed between lifeboat and ship, but this is obviated with an inflatable raft, which flexes with an obstruction.

Fourth, launching lifeboats in a heavy sea or during an adverse list are problems for which no complete answer has been found. However, the inflatable raft can be launched from anywhere on the vessel. Even the largest types can be carried by four men, and thrown over the lee side at a position most convenient for boarding.

Fifth, sea-worthiness is a strong factor. By incorporating bags which fill with water on the under side, almost complete stability is maintained under the worse conditions. The canopy opens at each end to allow entry, but is equipped with flaps or curtain. Even when reasonable ventilation is allowed, no water may enter the raft. Constant bailing, therefore, is a thing of the past.

Stays Where Searchers Can Find It

Sixth, because the liferaft has no means of propulsion, it remains near the scene of the disaster. Today, with extensive air-sea rescue services, it is safer to wait for rescuers rather than try to reach distant land. The searchers' job is made easier because the raft is thus only subject to known conditions of wind and tide, and a group of rafts will remain near each other. The canopy contains bright-colored flourescent materials, for easier spotting from the air.

Each liferaft is equipped with an

QUILTED FLOOR, *canopy overhead, and seats around the edge make the new rafts seem like "luxury" equipment, compared to old-style open life boats. From the center of the canopy hangs the rainwater catchment pipe. An emergency pack contains a three day supply of food and water, signalling devices and first aid kit. (Cory Brothers & Co., Ltd.)*

Emergency Pack, the contents of which are designed to deal with three major factors:

(a) Survival in the form of food—sweets, biscuit ration, and tins of fresh water.

(b) Attention attracting—a flashlight or torch, complete with spare batteries; distress signals, and hand flares. Also a heliograph.

(c) Raft emergencies—first aid kit, bellows, repair outfit, sea-sickness tablets, and instructions.

Enough for Three Days

In all, the Emergency Pack will keep the full complement of survivors in good condition for three days. To supplement the water cans (which permit two-thirds of a pint per person per day) a rainwater catchment is provided, and a rubber tube carries the flow from the canopy to empty tins, where it may be stored until required.

Two Outstanding Rescues

Already the inflatable liferaft has established itself in the British fishing industry. Since October, 1956, it has been compulsory for all vessels between 50 and 145 feet in length to carry such equipment for all on board, and during that year not one life was lost due to a vessel sinking. Four ships

went down, but the 59 persons on board them were saved by inflatable liferafts.

One particular rescue which best pays tribute to the stability of inflatable liferafts under severe conditions took place during a heavy storm when an ocean-going trawler was driven aground with a following sea. Both lifeboats were smashed to bits, and yet the crew of twelve were picked up within an hour from their inflatable rafts. Of rescues in 1957, an outstanding one was that of the crew of the fishing boat *Marcia,* which was holed when a flywheel broke loose from the engine. In this case, the crew drifted for 59 hours in an inflatable liferaft and were so comfortable that the captain remarked he was better off in the raft than he was in his own bunk!

These rescues are in happy contrast to the sinking of the *Princess Victoria,* a ferry steamer operating between Scotland and Ireland, when 128 lives were lost.

Comes in Small Sizes, Too

The small boat owner also can benefit from recent developments in the inflatable raft business. Rafts, which can be compressed into a package only 30 inches long and 15 inches in diameter, will carry four people.

One obstacle to the use of inflatable liferafts aboard all ocean-going tonnage is the 1948 International Convention for the Safety of Life at Sea. The British Government, which is the convening nation for this, is now recommending a new Convention for 1960, when the problem of extending the adoption of inflatable liferafts can be explored in greater detail.

Another question mark is the stowage and launching of rafts from passenger ships. Trawlers have already been designed to incorporate inflatable liferafts, but no passenger ships have been designed from the start for inflatable liferafts. All trials carried out to date have been with vessels which were either in being, or had inflatable liferafts added at some stage during building. Reduction in top hamper permitted by inflatable rafts, combined with additional streamlining, are two factors that appeal to every modern naval architect.

Research Program Continues

Research into ways and means of improving inflatable liferafts goes on, including investigations into new fabrics and new stowages. Compact homing-radio equipment is also on the agenda. Progress is restricted only by the need of testing every development before adopting it. Mass launchings and tests under all weather conditions are almost daily occurrences. The principle of the inflated liferaft has been proven, and its advantages shown many times over in actual rescues. The rest of the story is the ever increasing confidence of Maritime Authorities, reflected in their recommendations and instructions regarding the carriage of this new device aboard vessels under their jurisdiction.

RACING FOR "TUNA ALLEY." *Scientists as well as sportsmen enjoyed an extra dividend at Cat Cay, Bahamas, this spring when, in addition to the 14th Cat Cay Tournament, a new competition, sponsored by the Bahamas Government and known as the Bahamas International Tuna Match, was successfully launched. Since the taking of bluefin tuna and other deep water fishes has become a competitive sport, with catches brought ashore for weighing and measuring, game fishermen have afforded unusual opportunities for the study of many full-grown specimens, and marine biologists are taking full advantage of the chances to do so. (William Doheny)*

Tournaments Can Aid Science

By ERL ROMAN

WHAT DOES DEEP-SEA game fishing have in common with the marine sciences? This is a question often asked of scientists who attend gatherings and tournaments of big game anglers in many parts of the world.

The answer is fairly simple. Very little is known of the life habits and characteristics of bluefin tuna, marlin, swordfish and other large pelagic, or open sea, fishes. These blue-water wanderers spend virtually all their lives far from shore, where they are not readily available to the marine biologist who would like to know more

about such important matters as breeding grounds, the why and wherefore of their annual migrations and other habits which at best remain partial mysteries.

Baby Elephant Size!

Catching fish that weigh as much as a baby elephant (400 to 700 pounds) also requires not only skill but expensive equipment. The average scientist has neither the funds, nor the gear, to pursue such a highly specialized activity. However, since the taking of bluefin tuna and other big fish became a "competitive sport," with catches brought ashore for weighing and measuring, unusual opportunities have been afforded for the the study of full-grown specimens, and marine biologists have been quick to take advantage of the chances to do so.

Nowhere are there better prospects for gaining new knowledge about such elusive fishes as at the spring tournaments held at Cat Cay and Bimini, Bahamian Islands, close to the Gulf Stream "mainline of the big ones." For reasons that are still not clearly understood, bluefin tuna follow the western edge of the Great Bahama Bank, close inshore to Cat Cay and Bimini, on their yearly migration to the coastal feeding areas of the North Atlantic States and Nova Scotia. The vanguard of the tuna hordes appears in the Gulf Stream, about 50 miles east of Miami, early in May. The run reaches its peak during a period extending from May 22 to June 7, with the last of the stragglers vanishing from the Bahamas fringe area by the end of June.

Hemingway a Tuna Pioneer

Despite the acclaim given tuna fishing in the outer Bahamas during recent years, its history as a sport does not go back more than a quarter century. Prior to 1932 there were a few reports of big sea creatures that struck hard at the bait of anglers fishing the reefs and "drop off" in the Cat Cay-Bimini area. No one saw them because they ran deep, and either snapped the line or completely stripped it from the reels.

By 1933 and 1934 experienced fishermen surmised that these fish might be tuna, and fished for them with heavier line and gear. The surmises proved correct when several shark-mutilated tuna were brought into Cat Cay and Bimini. The first unmutilated tuna to be brought to gaff was landed by the famous novelist, Ernest Hemingway, during the 1935 season. A total of fourteen unmutilated tuna (and therefore eligible for weight and size records) were successfully boated that year, establishing the Gulf Stream off the Bahamas as the equal of, if not better than, any area in which such giant fish might be caught.

Echo-Sounding Gear Used

During the period of the 1958 tuna run, the R/V *Gerda,* research ship of The Marine Laboratory, University of Miami, appeared off Cat Cay. She looked mighty nice among the charter boat fleet of the game fishermen, but the *Gerda* was there on business. Using her echo-sounding gear, she probed the deep waters of the Straits of Florida in an attempt to discover if there were any bottom ridges or can-

yons that might influence the movement or direction of the tuna schools.

With the same equipment, the *Gerda* attempted to learn if tuna were running heavily offshore when they were not running inshore, and vice versa. Results of the tests showed no ridges or canyons, nor heavy offshore runs, but valuable readings were obtained on the so-called "scattering layer."

Dr. Charles E. Lane, of The Miami Marine Laboratory, made good scientific use of four of the bluefin tuna landed during the tournaments. He dissected out of one of these fish a curious structure known as the pineal body. This is actually a portion of the brain which is connected with the skin on the top of the head by a tube. In a few rare creatures this actually functions as a "third eye." The question confronting Dr. Lane is whether the pineal body in the bluefin is able to detect light at all. Microscopic examination of the tissues may give the answer.

Among others engaged in research at Cat Cay was a team of three scientists from the Retina Institute, of Boston, Mass., who obtained specimens of the eyes of several tuna. These were to be taken back to Boston to be used in basic eye studies. This team was operating out of the Lerner Marine Laboratory, Bimini, where the members are conducting other research work.

FOR BIG STUFF. *Prior to 1932 there were reports of big sea creatures striking hard at the bait of anglers fishing the reefs and "drop off" in the Cat Cay-Bimini area. No one saw them because they ran deep, and either snapped the line or completely stripped it from reels. Experienced anglers correctly surmised that these fish might be tuna, and might be caught with heavier line and gear, such as that shown below. In recent years this Bahamas area has become the gathering place of some of the world's leading anglers. (Sam R. Quincy)*

Atlantic Big-Eye Tuna

During the International Match at Cat Cay, a 182-pound tuna was caught which looked "different." That it was not a bluefin could be easily ascertained by comparing it with nearly a score of these giants on the dock at the same time. Nor was it a yellow-fin (sometimes called Allison tuna), for the dorsal and anal fins were not prolonged, as are those of a yellow-fin of

MARINE BIOLOGISTS *examine the stomach contents of a small ocean game fish. Because tuna, marlin, swordfish and other large pelagic or open sea fishes spend virtually all their lives far from shore, very little is known of their feeding habits, and other characteristics, such as their breeding grounds, and the why and wherefore of their annual migrations from the tropics to cold northern waters. Game fishermen and charter boat captains are cooperating fully with scientists by making catches available after the big fish have been weighed and measured. (Marine Laboratory, University of Miami)*

this size. The fish had a wider and deeper body than other tunas, and a noticeably larger eye.

Dr. John E. Randall, ichthyologist with The Miami Marine Laboratory, examined the fish at Cat Cay and identified it as the Atlantic big-eye tuna *(Thunnus obesus)*. Other clues to this seldom-seen species are 27 to 28 gill rakers, a pectoral fin more than four-fifths of the head length, finlets brownish yellow with broad dusky edging, and striation on the posterior ventral margin of the liver.

Incidentally, two other tunas of the genus *Thunnus* are found in the At-

BIG-EYE. *Mrs. Pablo Bardin, of Buenos Aires, and the rare 182-pound Atlantic big-eye tuna which she landed as a member of the Argentina team, during the first annual Bahamas International Tuna Match, held at Cat Cay, May 29 to June 2, 1958. This is believed to be a world's record in this species for women. The Argentina team finished second in the International tourney. (Bahama News Bureau)*

lantic: the blackfin tuna, which has brownish gray finlets and rarely exceeds 25 pounds, and the albacore, whose long pectoral fin easily distinguishes it.

Previous Findings and Research

The work done by scientists at tournaments this spring recalls findings and research conducted in the Bahamas during previous meetings of anglers and marine biologists, including liver analyses of tuna by Dr. Charles E. Lane; comparison of east and west Atlantic tuna to determine "Do these mix?" by Dr. C. Richard Robins; breeding conditions by Mr. Luis Rene Rivas; feeding and stomach contents of tuna, by Dr. F. G. Walton Smith and others; and growth rate through examination of scales and vertebrae, by Dr. Robins and Mr. Rivas.

Scientists as well as sportsmen enjoyed an "extra dividend" at Cat Cay this spring. In addition to the widely-known Cat Cay Tournament, the 14th edition of which was held May 21 to May 25, a new competition, sponsored by the Bahamas Government, and known as the Bahamas International Tuna Match, was successfully launched between May 29 and June 2. It is hoped that this meeting, too, can become an annual affair.

In the traditional Cat Cay Tuna Tournament, nineteen anglers competed with Bill Carpenter, of Wilmington, Delaware, winding up in first place. Carpenter has now won five of the past six tournaments at Cat Cay. This time he boated seven giant bluefins, for a total poundage of 3,263.

Cuban In Second Place

Alin Suero Falla, of Habana, Cuba, placed second to Carpenter, taking five tuna weighing a total of 2,170 pounds. In third place was J. W. Griffith, of Longview, Texas. Griffith caught four tuna that scaled a total of 1,691 pounds.

Charles F. Johnson, of Palm Beach, president of the International Oceanographic Foundation, weighed in the largest tuna caught during the opening

tournament, a 622-pounder, and was awarded the special Aksel Wichfeld trophy, donated by Robert E. Maytag, of Ponte Vedra Beach, Fla. Maytag, incidentally, is one of the trustees of the International Oceanographic Foundation.

For the first time in the history of the Cat Cay Tuna Tournament a woman angler, Mrs. Eric Heckett, of Cat Cay and Valencia, Pa., competed with the men anglers. She turned in two sizeable tuna for a total of 848 pounds, and placed ninth in the final tourney standings.

"Banner of Sportsmanship"

In his letter of invitation to participants in the first Bahamas International Tuna Match, Mr. Stafford L. Sands, chairman of the Bahamas Development Board, observed: "In these days of world unrest there is one universal banner under which all of us can meet—the banner of sportsmanship." It was the consensus of opinion of all who took part in this initial venture that it was marked not only by spirited competition, but was also a success from the viewpoint of more cordial international relations. A major contribution was made, too, by the highly-trained crews from Ft. Lauderdale, Miami and Palm Beach, who operated their charter boats with great skill.

A total of nine teams competed for valuable prizes, each team fishing as a unit, but changing from boat to boat as the contest progressed through five days. Teams, in the match represented Argentina, Bahamas, Cat Cay, Cuba, Mexico, Peru, Puerto Rico, United States and Venezuela.

The Bahamas team, captained by

FOR THE FIRST TIME *in the 14-year history of the annual Cat Cay Tournament, a woman angler competed with the men anglers. Mrs. Eric Heckett, of Cat Cay and Valencia, Pa., took two sizeable tuna for a total of 848 pounds, and placed ninth in the final tourney standings. Here she poses with one of her bluefin tuna prizes. (Bahama News Bureau)*

Dr. F. G. Walton Smith, director of The Marine Laboratory, University of Miami, and advisor to the Bahamas Agricultural and Fisheries Board, won first prize with its catch of six bluefins, weighing a total of 2,949 pounds. Other members of the team were John Bethell and Jimmy Robertson, of Nassau. Robertson caught the largest tuna registered in either of the two tournaments—weight 662 pounds.

World's Record For Women

In second place stood the team representing Argentina, also taking six tuna, for a total weight of 2,403 pounds. On the Argentina team were Señor and Señora Pablo Bardin, and Señor Gabriel Berlingieri. Señora Bardin, only woman in the International tourney, further distinguished herself by landing the big-eye tuna previously mentioned. This unusual fish weighed in at 182 pounds, a world's record in this species for women.

The Puerto Rico team placed third, with five fish weighing a total of 2,178 pounds. The team consisted of only two men, Esteban A. Bird and Angel Abarca. A third member, although entered, failed to arrive in time for the contest.

Teams from Venezuela, Mexico, United States, Peru, Cuba and Cat Cay finished in the order named. As an enjoyable climax to the match, a banquet was held on Monday, June 2, at which time trophies and prizes were awarded to the lucky winners. So concluded one more chapter in the angler's contribution to marine sciences.

Must Have A Real Stomach Ache!

OCEANOGRAPHIC research can become expensive when fish make off with equipment. That is what happened while a group from the Oceanographic Institute of Split, Jugoslavia, was securing hydrographic data near the island of Mljet, in the Adriatic.

Measurements were being taken with a reversing or Nansen bottle at a depth of 1,565 feet, when some unknown force began to draw the bottle down. An attempt was made to hoist it, but the mystery creature pulled so hard that the steel rope snapped, and all gear was lost.

The average Nansen bottle is two feet in length and weighs seven to eight pounds, with several projecting valves and bolts. So the fish that gulped it must have developed an oversized stomach ache. A member of the Institute suggests that valuable equipment should be painted a dull color or be made of non-glistening metals. Bright objects attract not only sharks, but other fish, too.

WHALE FACTORY. *At the beginning, Antarctic whaling was conducted from land stations; that is, whales killed in Antarctic seas were towed to processing plants or floating factories in the harbors of South Georgia, Graham Land and adjacent archipelagoes. Whaling is still carried out from such well equipped places as Leith Harbour, South Georgia, shown above. The large ship in the foreground is H.M.S.* PROTECTOR, *while catchers are tied up in a row at upper left. (Chr. Salvesen & Co.)*

Politics and the Antarctic Whale

By G. H. ELLIOT

TOO OFTEN, when we think of whaling, it is still in terms of "Moby Dick" — of bold adventure rather than as a business. But for many decades the hunting, killing, and processing of whales for oil, meat and by-products has been an industry operating at a rather high state of efficiency.

Modern whaling, in fact, dates back to the late 1860s, when the Norwegian sealing captain, Svend Foyn, successfully combined the steam whale catcher with a heavy gun firing an explosive harpoon. This technique made possible the killing of blue and fin whales, hitherto protected by their speed, in addition to the slower sperm, humpback and right whales, then being hunted all over the globe by American sailing whale-ships.

But, by the turn of the century, the old methods of open boat and hand harpoon, immortalized in the sagas of

A FLAGGED WHALE, *waiting to be picked up by the factory ship. The second pole carries a radar reflector, useful during heavy fogs. (Chr. Salvesen & Co.)*

New Bedford and Nantucket, had passed from the seas.

Quite naturally, the first fields to be exploited were those closest to the Norwegian coast. The new whaling soon spread to the Shetlands, Iceland, the Faroes, and later to the Pacific coast of North America. But the narrow oceans of the north were too small for the expanding ambitions of Norwegian and British whalers, and they turned their attention to the far South. The first whaling station, at South Georgia, on the fringe of the Antarctic, fired its boilers in 1904, and the first floating factory expedition came down the following year.

Southward Ho!

At the beginning, Antarctic whaling was carried out either from land stations, or from floating factories moored in the harbors of South Georgia, Graham Land and the adjacent archipelagoes. When the stocks of whales within range of land became depleted, the factories started to operate in the vast open seas. Whales were brought alongside, dismembered where they lay, and each piece painfully hoisted aboard.

Stern Slip Introduced

As factory ships grew in size, the stern slip was introduced, allowing the whales to be hauled up on deck and cut up there. The factory ship, no longer required to stay within more or less sheltered waters, ranged over the whole ocean, unaffected by all but the worst weather.

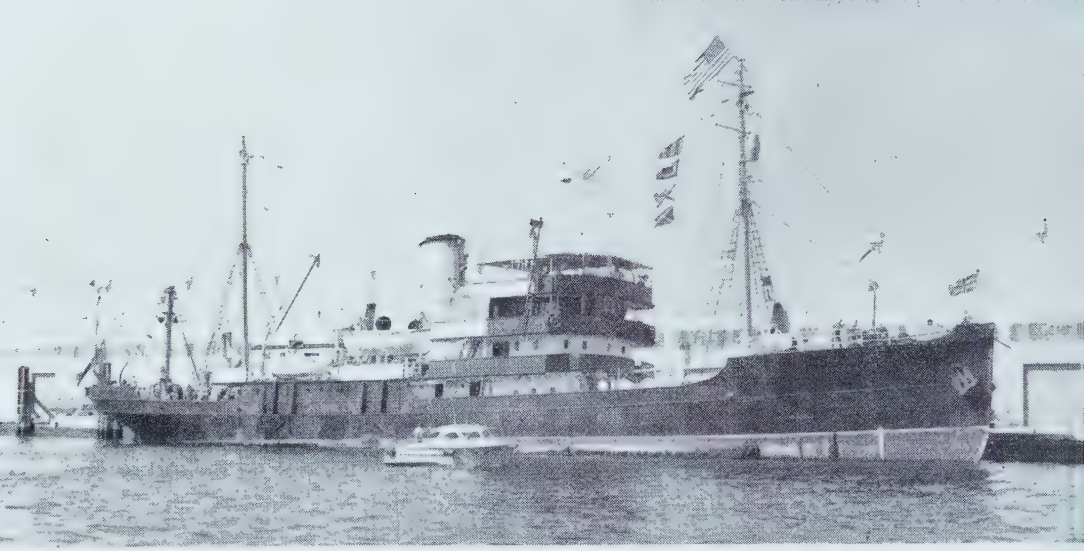
By the early 1930s, the pattern of Antarctic whaling as it is today had been established. Floating factories were operating continuously around the Antarctic from the Weddell Sea in the west to the Ross Sea in the east. Whaling is still carried on from land stations at South Georgia, but these now contribute only a small part of the total Antarctic catch.

Seasonal habits of baleen whales make the Antarctic the ideal catching ground. In the winter they remain in the warm, but barren, tropical waters. When summer comes they migrate to the Antarctic to feed on large concentrations of krill (a kind of small shrimp). Taking large mouthfuls of krill, they sieve out the water by pushing it through rows of hairy baleen plates, which they have in place of teeth. The calves are normally conceived one winter and born the next, accompanying their mothers south the following summer to get fat on Antarctic krill.

Blue, Fin and Sperm Whales

Blue and fin whales calve once every two or three years, and normally produce one calf only. The sperm is a toothed whale, living on squid or small fish. Its normal grounds are the warmer oceans, and it is only males that appear in the Antarctic during the summer.

The Antarctic catch is made up largely of blue and fin whales. Some humpbacks are taken, but their numbers are restricted by international agreement. The blue whale, largest of the baleens, ranges from 60 to over 90 feet in length, and a single animal may yield as much as 200 barrels of oil. Up to the mid 1930s, most of the whales taken by floating factories were blue whales, but as the stocks were reduced the catch concentrated



RESEARCH. *In 1924, the British Colonial Office set up a special committee to make a scientific study of Antarctic whales, in order to obtain data that might be helpful in drafting regulations for the control of whaling. A staff of qualified scientists, sent to the Antarctic in the Royal Research Ships,* DISCOVERY II *and* SCORESBY, *brought back much new and valuable information on whales and their habits. Above,* DISCOVERY II, *on a mission for the International Geophysical Year, refuels at Port Everglades, Florida. (E. John Long)*

more and more on the smaller fin whale.

What is a modern floating whale factory? Usually a large squat vessel of between 20,000 and 30,000 tons dead weight. It carries a crew of between 300 and 600, of which only a small part run the ship. The rest are the large number of whalers who dismember the whale on deck and look after the processing machinery below.

Modern Floating Factory

Each factory ship operates a small fleet of whalecatchers, varying in number from 7 to 18. These are specially-designed craft about the size of trawlers, with a speed of 15 to 17 knots. Each carries a crew of about 18. They have a high bow with a pronounced flare to keep the gun platform as dry as possible in heavy seas. Between bow and bridge a high mast with a crow's nest is kept continuously manned during whaling.

The bridge is similarly built to give a wide horizon for spotting. From there the gunner, who is usually also the captain of his ship, directs the hunt, going up to the gun via a connecting catwalk only in the final stages.

Some Use Helicopters

Operations of the whole expedition are directed by the factory ship manager, who is in constant touch with his gunners by radio-phone. On the bridge of the floating factory movements of the catchers are closely recorded. Control boards show the number of whales killed and which catchers are being used as towboats to bring the whales in. Some expeditions use helicopters to spot whales, but air operations are often hampered by unsuitable weather conditions.

In the early years of Antarctic whaling, ships took only the blubber, dis-

carding carcasses that still contained a large part of the potential oil yield. Soon the bones, nearly as rich in oil as blubber, were cooked out too. Meat, most of which holds little oil, continued to be thrown overboard until 1935, when an international agreement made it compulsory to cook it. At land stations, where production was not limited by space, meat and bone had always been processed into a meal.

Before World War II, experiments with by-products did not always pay off. Since the War, stimulated by the high demand for animal protein, whale by-products have been devoloped on a large scale. In addition to meat meal (for cattle food), the list includes frozen meat (pet food), meat extract, liver oil (containing natural vitamin A), and solubles (concentrated protein liquor, also for cattle food).

Life on Board a Factory Ship

To understand modern production methods, let us take a look at the operations of the floating factory *Southern Harvester,* one of two sister ships managed by our firm, Chr. Salvesen & Co., of Leith, Scotland. The two main types of processing equipment on *Southern Harvester* are pressure boilers and rotating cookers. Pressure boilers, used for most of the bones and some of the blubber, are filled in turn with the vertebrae, ribs and jawbones as the whales are dismembered on deck.

Cooked for about eight hours, the mass yields a layer of oil which is tapped off and passed through purifiers to storage tanks. Remaining liquors still contain some oil, and these are treated in high-speed desludgers and separators before the residue is pumped overboard.

The best meat from each whale is fed into the meat meal plant, where large cutters shred it. The meat is then heated, pressed to remove free moisture and oil, dried under vacuum, ground, sacked and stowed. The product is a protein-rich cattle food of high nutritive value.

Equals Best Beef Extract

Liquors pressed from the fresh meat are filtered and evaporated to make meat extract, a recently developed by-product that has proved to be the equal of the best beef extract. The factory ship also carries a liver plant, which extracts the vitamin A bearing oil from the livers.

On a day of top production in the Antarctic, *Southern Harvester* can process forty 50-ton whales for a record production of 600 tons of pure whale oil, 130 tons of whale meat and other by-products with a total value of $170,000. Yes, whaling can be big business.

Until the 1930s virtually all Antarctic whaling expeditions were Norwegian and British. Then Hitler's Germany entered on a large scale, and Japan became interested. The war ended German whaling ambitions, but the Japanese have built up their industry again and now are second only to Norway. Russia and Holland have also joined the whaling nations since the war. There was a short, but exciting, intervention by a "wildcat expedition" under the Panamanian flag, operated by the Greek shipowner, Onassis.

KING-SIZE IS THE WHALE *(above) with the huge jawbone and baleen plates of a fin whale, being dismembered at a shore whaling station. In the early days of Antarctic whaling, the whaleships took only the blubber, discarding carcasses that still contained a large part of the potential oil yield. At land stations, where production is not limited by space, meat and bone have always been processed into a meal. (Chr. Salvesen & Co.)*

Need for Quotas

The history of whaling shows that economic factors usually halt whaling before a species of whales is hunted to extinction. But stocks may be so drastically reduced that recovery takes many years, particularly types which are slow-moving or easily taken. The northern right whale virtually disappeared in the mid 19th Century after two centuries of Dutch and British whaling. Humpbacks that once abounded in the bays of South Georgia were killed in such large numbers that they seldom appear in modern catches.

As soon as the last areas of the Antarctic were opened to whaling, both operating companies and governments saw they would soon have to concern themselves with conservation of whale stocks. Although baleen whales in these areas were infinitely more numerous than in any regions previously exploited, history would repeat itself, sooner or later, unless some means of restricting the catch were worked out.

Everyone in the whaling business realized that it would be foolish and probably useless to attempt to set up rules without knowing more about the lives and habitats of these huge pelagic mammals. Accordingly, in 1924, the British Colonial Office set up a special committee to make a scientific study of Antarctic whales, in order to obtain data that might be helpful in drafting regulations for the control of whaling.

Science Invades Antarctic

A staff of qualified scientists was selected and sent to the Antarctic in the Royal Research Ships, *Discovery II* and *Scoresby*. The many long voyages of these two vessels in Antarctic waters and the patient and arduous

work done by the dedicated men who sailed in them, resulted in the most extensive oceanographic findings since the expeditions of the *Challenger,* in 1872-76.

The work was fundamental and thorough. Certain meridians of longitude were selected, and along these, at intervals throughout the year, a series of observations was taken, including samples of sea water, temperature readings at fixed depths and net hauls of plankton, while a complete record was kept of whales, fish and other marine life observed.

Scientists also worked from a laboratory ashore, in South Georgia, where the carcasses of 3,000 whales were examined. The Norwegians, too, played a part in obtaining scientific data that was later considered by nations seeking some kind of "ground rules" to keep whales from being exterminated. Not only did the far-sighted Norwegians conduct whaling studies from their research vessel, *Norvegia,* but some research was also carried out on their own factory ships.

The whaling companies themselves finally took the first steps. From 1932 to 1937 various agreements were made, with or without government co-operation, to restrict the catch by quota arrangements or limitation of catch material. Included were provisions for minimum size limits, and specified starting dates for the season. These points were included in the International Convention of 1935 and the Agreement of 1937, which also required that all parts of the whale should be cooked for oil, and that factory ships should carry government inspectors to ensure that the provisions were obeyed.

German-Jap Holdouts

But the developing German and Japanese whaling fleets were not ready to accept catch restrictions, making it impossible to continue effective conservation measures after 1937. It was every man for himself, and during the season 1937-38 the number of baleen whales taken by floating factory expeditions in the Antarctic soared to an all-time record of 43,000.

Such slaughter could not go on. Finally, in 1945, an International Whaling Conference was called in Washington, and an International Convention drawn up and signed. The principles of the 1937 Agreement were reaffirmed and an overall quota set. This quota limited the total take to 16,000 Blue Whale Units for the first season. One Blue Whale Unit consisted of one blue whale, or two fin whales, or 2½ humpbacks.

With blue whales forming about 25% of the catch in early post-war season, the total number of whales

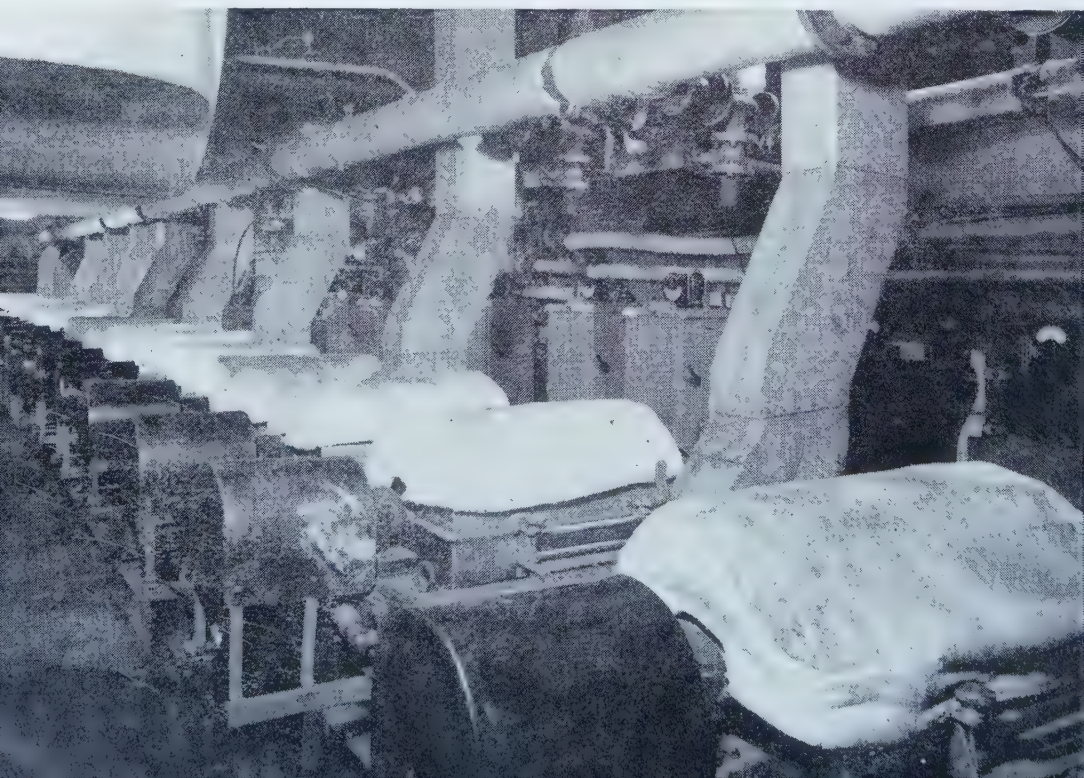
SOUTHERN VENTURE, *of Leith, Scotland, a modern whaling floating factory. In addition to a small fleet of whale-catchers, the factory has its own helicopter to spot whales. When the weather is stormy the plane is housed in a hangar between the funnels. Note the opening in the stern, through which the whales are hauled for processing on deck. (Turners, Ltd.)*

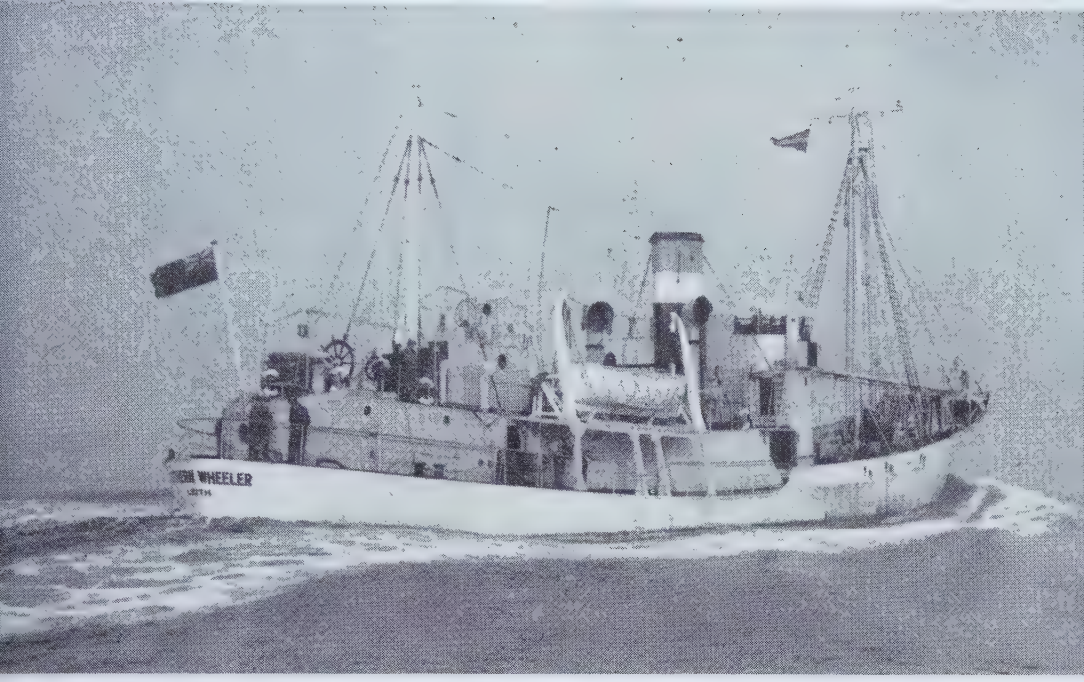
taken, while over the quota, was about 26,000, a substantial reduction from the pre-war catch.

Since 1946 an International Whaling Commission, consisting of representatives of the signatory government to the Convention, with their scientific and industrial advisors, has met each summer to consider whether changes are required for the coming Antarctic season in minimum sizes for taking whales, dates of the season, or the overall quota. Scientists feel that the quota of 16,000 units will have to be substantially cut to prevent whale stocks from being depleted. Against this, whaling expedition operators stress that if a large and sudden reduction were made in the quota, most companies would go out of business. So there has been a gradual reduction in the quota to 14,500, the present limit.

One great difficulty has been the enforcement of Commission agreements. Each member country implements the agreements by national legislation, and puts inspectors on board expeditions flying its flag. But flagrant and repeated violations have taken place, by the Panamanian expedition of Onassis, and by Russian expeditions. The Panamanian expedition has since been sold to Japan, but Russia still fishes without restraint, although the Russians claim to be one

INSIDE A MODERN FLOATING FACTORY SHIP. *After the body of the whale has been cut up on deck, various portions of it are processed below into oil, meat meal (for cattle food), frozen meat (pet food), meat extracts, liver oil (concentrated natural vitamin A), and solubles. Liquors pressed from the fresh whale meat have proved to be the equal of the best beef extracts. The machines below are high-speed centrifugal desludgers which capture the last remaining oil from the cooked blubber and bones before the residue is pumped overboard. (Turners Ltd.)*





WHALECATCHERS. *A number of specially-designed craft about the size of trawlers, accompany each factory ship. After the whale has been spotted from the crow's nest atop the foremast, the captain of the ship, who is usually the gunner, hurries up the catwalk that leads from the bridge to the bow gun. With a speed of 15 to 17 knots, the whalecatcher moves in quickly for the kill. (Chr. Salvesen & Co.)*

of the most enthusiastic supporters of the Whaling Convention. Other whaling operators now feel that, in these circumstances, reductions in quota merely handicap those who obey the rules, and that no further restrictions should be imposed until everyone respects the agreements.

Neutral Observers Might Help

It was proposed in 1957 that a neutral observer be put on board each floating factory to check on deliberate violations, and some progress has been made in discussing this scheme. It is doubtful, however, whether Russia will accept it.

High prices of whale oil in the years just after World War II encouraged new expeditions to enter Antarctic whaling. This meant a smaller share to each of the overall quota, and this has been further lessened as the quota itself was reduced. Competition, however, has ensured that equipment be continually improved and renewed, and that full use be made of such developments as "asdic" for following whales in the water, and of helicopters to spot them from the air.

But the present low price of oil, and inevitable increasing level of costs, now makes it difficult for British and Norwegian expeditions to earn enough even to cover capital depreciation. For the Japanese the picture is brighter. Crew costs are much lower than those of European competitors, and they have assured markets in Japan for frozen meat and other by-products as human food. A Japanese company recently bought the British registered vessel *Abraham Larsen,* and our

GIANT BUTCHERS. *This is a scene that has some historical significance, because shore whaling stations, such as this one at Leith Harbour, South Georgia, are slowly being replaced by huge factory whaling ships, operating independently. On a favorable day a factory ship can process 40 whales, obtaining up to 600 tons of pure whale oil, and 130 tons of meat and other by-products. (Chr. Salvesen & Co.)*

own *Southern Venturer* would also have gone to Japan if the intending purchaser had not been refused a license.

Russia Expanding Operations

The other two whaling nations, Holland and Russia, have state-subsidised or state-operated expeditions, and so can afford to ignore costs. The Soviets are reported to be equipping three new expeditions. When these are added to the twenty now operating, prospects for private operators will be dim indeed.

It is difficult to say why the Russians are so vigorously expanding their whaling interests. There certainly can be no economic basis for it, on any rational basis of calculation. It would be reasonable to guess that political interest in the Antarctic is one of the factors. Another consideration is the fact that whalecatchers could be easily converted into valuable naval patrol or supply ships. But their activities might quite simply be directed to force other nations out of the industry, as part of the cold war. There is a parallel to this in their expansion in the Arctic fisheries.

Used Mainly In Margarine

Whale oil is at present used entirely for edible purposes, mainly in the manufacture of margarine. It is therefore a very close competitor of vegetable oils, such as palm and groundnut oil, and prices tend to move together. During the scarcity years, immediately after World War II, the price rose to over £100 ton; recently

it has varied between £67 and £90 per ton ($187.60 and $252.00).

As for the future of Antarctic whaling, many factors are involved. Statements of scientists on the rate of depletion of the stock admittedly are based on somewhat sketchy evidence. Nevertheless, the experience of whalers does indicate that stocks have decreased in recent years, although the continuous improvement of whaling methods has masked this. Such a decline, which will probably be reflected in further cuts in the International Whaling Commission quota, must in time reduce the number of expeditions. It may, unless some other form of control can be introduced, leave only a few low-cost or state-subsidized floating factories in Antarctic seas.

I. O. F. Aids Oceanographic Congress

THE LARGEST and most representative group of oceanographers ever to assemble in one meeting will gather at the United Nations Building, New York, August 30th through September 12, 1959. The occasion is the International Oceanographic Congress, sponsored by the American Association for the Advancement of Science in cooperation with the United Nations and the Special Committee on Oceanic Research.

Top-ranking scientists from all parts of the world, including physicists, chemists, biologists and others working on oceanographic problems and studies, will take part in two weeks of important discussions devoted to the fundamentals of marine science, ranging from the history of oceanography to the organic and inorganic substances of the deep sea. It should be an exciting and fruitful conclave.

Sponsors of the Congress hope that it will be the first of a series of such meetings to be held at intervals of several years and in different countries. They hope to encourage the participation not only of the older and better known scientists, but also the younger workers in marine laboratories throughout the world.

The International Oceanographic Foundation, through the generosity of a corporate associate, will assist in paying the travel expenses of a number of scientists from Scandinavian countries. Chairman of the Committee on Arrangements for the 1959 Congress is Dr. Mary Sears, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts. Other members of the Committee are: Gustaf Arrhenius, John Cushing, Henry M. Stommel, Fritz Koczy, George S. Myers, Roger Revelle, Gordon Lill, Lionel A. Walford, and Dael Wolfle (ex-officio.)

BOTTLES, BOTTLES, BOTTLES. *When the exciting adventure of collecting plankton at sea is done, then comes the equally important, but tedious, job of laboratory study and classification. (Charles E. Lane)*

Footnotes of a Plankton Chaser

By HILARY B. MOORE
The Marine Laboratory, University of Miami

WE LIVE IN AN AGE when machines do work of all kinds, far faster than would be possible with human hand and mind alone. An obvious example is the electronic brain, but there are others all around us, from farm machinery to modern transport. We would naturally expect scientific research to be the greatest user of its own laborsaving inventions, yet there are still many research problems that can only be carried out by laborious hand methods.

Take, for instance, marine biology. A technical report on a piece of research never shows all the trials and tribulations that have gone into its making. So, let us look at a typical research project in marine biology. A day or so in the life of a marine scientist, if you will, so we may find out just what keeps him busy. Suppose we select a plankton problem, dealing with the tiny drifting sea life. Because plankton is the basic food of the sea and because it affects underwater sound instruments, a knowledge of its movement is important.

Only One-eighth of an Inch Long

Most plankton swims downwards in the morning and rises toward the surface at night. A copepod, which is a little crustacean only an eighth of an inch long, may swim as much as a thousand feet each way every day. This is a prodigious distance for a small creature. It seems to be following changing light conditions, but it has been discovered also that both temperature and light may stimulate movement one way or another. It is as if three factors are pushing the copepod around until it finds a depth where the pushes balance out. If the actual strength of these pushes was known it would be possible to calculate just at what depth plankton could be found under any kind of conditions.

Unfortunately we cannot bring copepods into the laboratory and experiment with them as one might with a fish or an animal. They get upset in the process and do not behave normally. So it becomes necessary to locate their position in the sea under various light and temperature conditions and then try to calculate, mathematically, the relations between the depths in which they are found and the strength of these conditions.

It All Sounds So Simple

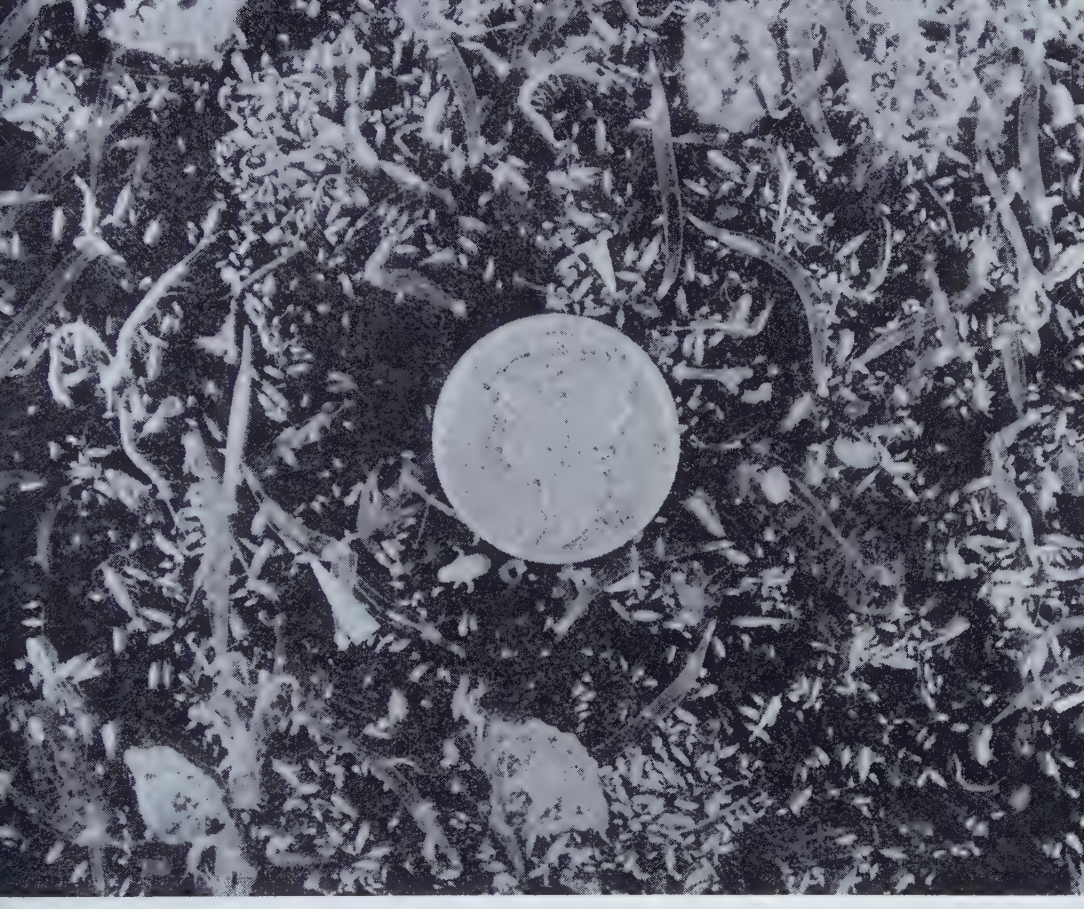
To catch such plankton, nets are lowered from a ship by a cable, towed for about half an hour, and then closed. The nets are brought on board and the catch preserved. Sounds simple, doesn't it? But it really isn't. The work is carried out on a rolling deck, with the weather often getting so bad as to risk damaging the nets as they are handled over the side of the boat. It means fishing the nets at a succession of depths, so as to locate

the creatures as accurately as possible. This must be kept up for a full twenty-four hours, in order to cover all of the changing light conditions.

It also means sending down other instruments that measure the temperature, the light, how deep the nets were fishing, and just how far they were towed. And on top of this, there is the inevitable trouble with instruments that work beautifully in the laboratory but develop bugs the moment they are taken to sea.

For instance, we have established

SCIENTISTS EXPLORING *the depths of the sea do not always probe for monsters. Much still is to be learned about tiny plankton, such as these specimens captured in a bottle at the end of a long trawling net. This photograph was taken on* M. V. GERDA, *research ship of The Marine Laboratory, University of Miami. (Charles E. Lane)*



PLANKTON, MYRIAD HOST OF THE SEA. *Because it provides the basic food for nearly all creatures in the ocean, plankton must not become contaminated by radioactive wastes, now being dumped in the ocean. The thin, eel-like creatures are the rapacious arrow worms, others are copepods, salps, mollusks, etc. (Marine Laboratory, University of Miami)*

twenty-four hour stations in different places near Miami. If all had gone as planned, there would have been forty-eight net hauls at each, but, with one thing and another, the final result was a total of only about five hundred hauls for the thirteen stations. Even that produced quite a lot of plankton.

Next came the counting of the copepods from the catches. To do this it was necessary to identify them. One net haul might have as many as fifty different species, not to mention all the other kinds of animals mixed in.

Sixteen of the commonest species were chosen and assistants were trained to recognize them on sight. Now to work on the five hundred hauls. Fractions of each in turn were placed under a microscope, and counts were made of how many of the sixteen kinds were in each fraction. That made 5,300 counts. They took quite a little while to complete and small wonder. Few of the animals are over an eighth of an inch long, and they are distinguished apart by

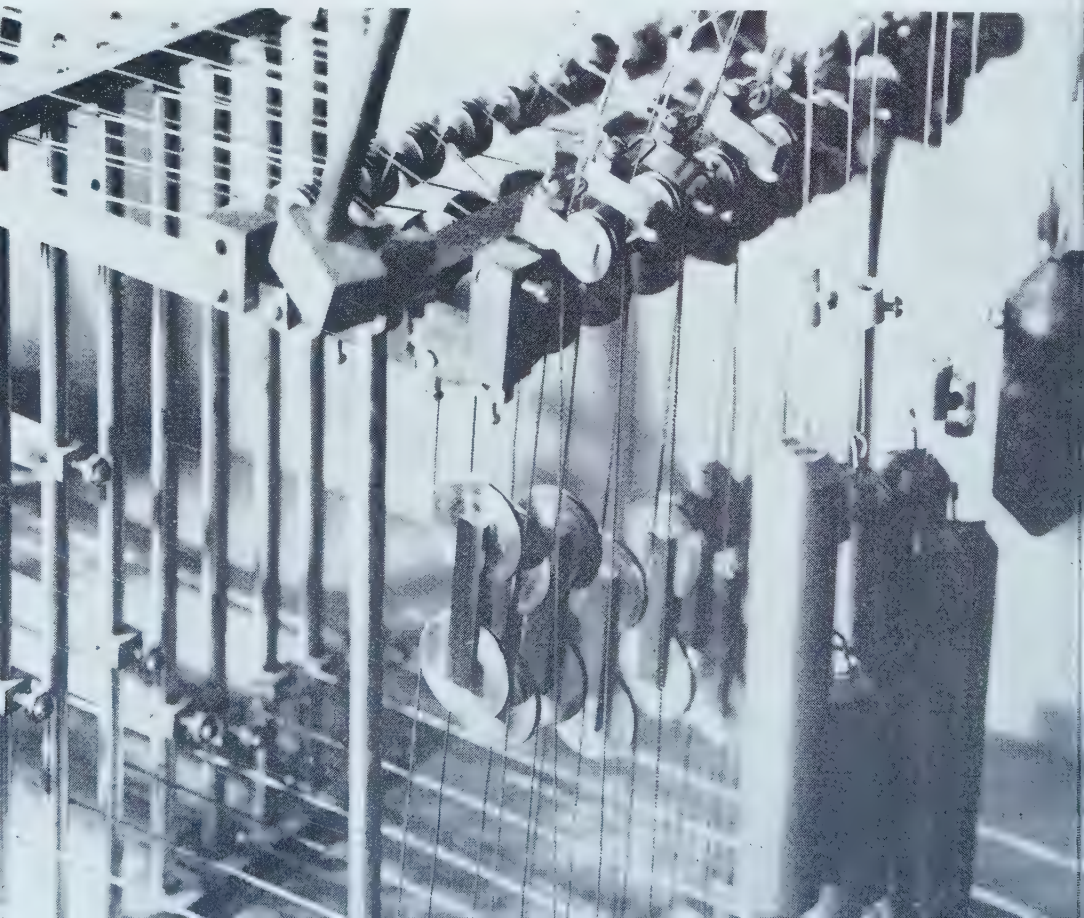
such minute things as the arrangement of bristles on their legs!

At the same time the instrument readings were being tabulated. Thus, for every net haul, there was a corresponding pressure, temperature and light value. These observations totalled 1,500. By now, after a year's work, there were 6,800 numbers to play with. The time had arrived to find out some facts about the first of the copepods.

To describe all of the manipulations of those numbers would be dull and tedious. Briefly, they were set in groups and added and subtracted. They were cross multiplied and squared and square-rooted. Several note books slowly became filled with figures and several small parts of the calculating machine wore out in the process.

To solve one equation it was even necessary to build a Rube Goldberg machine that fills a whole laboratory bench. It is full of pulleys and levers and wires and always seems to make a profound impression on visitors to the laboratory. At the end of the sec-

INFERNAL MACHINE? *No, this Rube Goldberg-like contraption is simply a portion of a device used to solve equations based on observations made from plankton net hauls. At the end of the second year of operation, this time-saving gadget had produced two small tables of figures and a half a dozen graphs. (Marine Laboratory, University of Miami)*



ond year the results were two small tables of figures and half a dozen graphs.

These tell quite a lot. They show that a population of copepods contains members with just as different individualities as our own. Some like more light than others, and some choose cooler conditions than others. They sort themselves out to levels where they can best satisfy these likings. They also reveal that the animal's behavior changes day and night. For instance, it changes its preferred temperature. And it responds energetically if the temperature is not to its immediate liking. The same is true of light and pressure. All told, the situation is quite complicated.

Typical or Eccentric?

Even this is not the end. Things had been worked out for just *one* kind of copepod. Was this one typical, or were we unlucky enough to make a start on a kind that is quite peculiar in its behavior? This can only be determined by repeating the work on the rest of the sixteen, or at least on several of them. Fortunately, this will not take quite as long as for the first copepod, because the methods are worked out and the machines ready to help with the calculations wherever a machine can. Perhaps another year will see the end of most of it.

This, then, shows something of the hidden work that lies behind a published report. Perhaps it may be more complicated than most problems in marine biology. At least it should be clear that in such problems, time and manpower limit the amount of deductions which can be accomplished. More and better machines must be developed to take the place of personal manipulation. Herein may lie the next big advance in marine biology.

Wave Counter Attack?

CAN WAVES be slowed up and their destructive forces dissipated? The British expect to have an answer to this question following a series of tests with an apparatus installed around the entrance to Dover harbor along the English Channel. It consists of a series of pipes, laid on the sea floor, which give off heavy streams of air bubbles. The basic technique is that the upsurge of air causes countercurrents that slow the velocity of waves at the surface and interfere with the powerful rhythms of wave cycles.

Although the underlying principle has been known for more than a half a century—an American took out patents for a bubble-curtain in 1907—this is the first large scale installation. If finally successful, the apparatus is expected to find usefulness not only in protecting small harbors from storm waves, but also oil rigs and radar outposts at sea.

UNDERWATER SPACEMAN. *This ingenious, power-driven device enables the skin diver to travel considerable distances without the exertion of swimming. The usefulness of such underwater vehicles is not limited to the quest for sunken treasure, but should be valuable to marine scientists in their studies of the reefs. (Silver Springs)*

Science of the Sea in Books

Books for the general reader are indicated thus, **(Gen.)**; those of interest chiefly to professional scientists, **(Pro.)**

1001 LOST, BURIED OR SUNKEN TREASURES. **(Gen.)**

F. L. COFFMAN. Thomas Nelson & Sons, New York. 1957. 277 pages. $5.00.

Buried or sunken treasure has been the motive for more high adventure, romance and derring-do than possibly any other type of marine venture. Indirectly, treasure hunting has played its part in oceanography by encouraging the development and improvement of diving bells, helmets, underwater cameras, self-contained diving devices, such as Aqua-Lung, and even ship salvage equipment.

If the quest of sunken wealth seems to be a thing of the past, a school-

boy's dream perhaps, Mr. Coffman's book will come as a surprise. It includes not only hints and legends but also documented up-to-date facts about hoards still there for the taking, although the taking may not be easy.

His research on buried and sunken treasure has turned up such startling items as: since 1500 A.D., one-eighth of all the gold and silver mined has been lost in marine disasters (including piracy); U.S. Hydrographic Office records show that the average annual loss in *documented vessels* is 2,172 ships; thousands of lost, buried, sunken or misplaced treasures, to the total approximate value of $275 billion dollars, have been reported, and this is believed to be only a fraction of the hoards still hidden.

The last 22 pages of the book contains a long list of the treasure ships sunk in the Western Hemisphere, and the actual or approximate location of each.

Although not a scientist, Mr. Coffman is exceptionally well qualified to write about a subject that now requires much technical skill and the use of scientific, as well as mechanical, devices. In addition to being the head of two companies dealing in marine salvage equipment, the author is president of Quest Associates, a group now engaged in organized searches for treasure in the Caribbean area. E.J.L.

GAME FISHING OFF THE AUSTRALIAN COAST

(Gen. and Pro.)

ATHEL D'OMBRAIN. Angus & Robertson, Ltd. Sydney and London. 50 shillings. 230 pp.

This book is a *must* for any one intending to fish off the East Coast of Australia, but limited to the East Coast, because it is weak on both South and West Australia. This weakness is understandable, for the good reason that there is much less game fishing on the two latter coasts, with the exception that game fishing is about as well-organized in South Australia as it is in Queensland, the northern half of the East Coast. The author does not pretend personally to know either of these areas, but the chapter on Queensland, by his youthful co-author Peter Goadby, is well done, informative and inclusive.

The seven pages on South Australia contain a fascinating account of Great White Shark fishing in Spencer Gulf, by the outstanding South Australian G. R. ("Jim") Cowell, but has less than two pages dealing with other fishing off that coast. It is too bad that D'Ombrain did not persuade Cowell to do a job similar to Goadby's, because Cowell has fished all of the waters of St. Vincent Gulf, Kangaroo Island, Spencer Gulf, including the outer islands in the Southern Ocean and the tuna and shark waters to the east off the Great Australian Bight. He holds the 20 and 12 pound test Australian records for Southern Bluefin tuna taken off the coast.

There is also an imbalance in the treatment of the game fishing areas of New South Wales, 29 pages for Port Stephens, to only ten for Sydney and eight for famous Bermagui. But this is natural, because the former is the author's home fishing ground and the other sections amply cover their areas. For American big game fishermen, who are lucky to live in the country where this type of fishing first developed and where, because of the number of participants, technological development has been extremely rapid, the chapters on gear, tackle and fishing methods are chiefly of interest because they are full of good, common sense "lore," born of the long experience and power of keen, intelligent observation of the author. For this reason, the volume should have a place on the shelves of anyone who

nas a big game fishing library. This is clear, although these chapters indicate a lack of experience with a few more modern technological developments, such as Dacron line, glass tips, ball-bearing swivels, etc.

It seems too bad from an international point of view that in Chapter 9, "Game Fish of Australian Waters," the author does not in many cases give the common names used in other parts of the English speaking world, where the fish exist, as Roughly does in his "Fish and Fisheries of Australia" (Angus and Robertson, 1951), for instance: striped tuna="skipjack"; mackerel tuna="false albacore"; Long Tom="Needle-fish," etc.

As a result the visiting American fisherman must take with him not only D'Ombrain's but Roughly's book, if he wants to know whether his Australian fishing companions are talking about a fish he catches at home or not. Much more technical and only applicable to the non-Australian scientists, who are not specialists in the field of *Xiphidiae* and *Istiophoridae*, or scientifically minded big game fishermen, is the lack of having given some of the more commonly used scientific names for the members of this family, as well as those evidently adopted in Australia for the time being; as follows:

Xiphias estara=Xiphias gladius; Marlina zelandica = Makaira mitzukurii; Istiompax australis (and probably *Istiompax dombraini) = Makaira marlina; Istiompax howardi=Makaira mazara* and *Istiophorus ludibundus= Istiophorus orientalis*. But perhaps the scientific nomenclature of the Istiophoridae is in such a mess that it makes little difference as long as the English common names are recognizable to the rest of the English-speaking world.

Again, unless the school be lost sight of for looking at the fish, "Game Fishing off the Australian Coast" is a grand book on game fishing by a grand game fisherman from a game fishing area which is not well represented in the sporting literature.

J.K.H.

World's Highest Tides

Twice a day the world's highest tides funnel into Nova Scotia's Minas Basin, the eastern branch of the Bay of Fundy. The waters may rise 53 feet, or the height of a four-story building. Neighboring creeks become swollen by the flow into broad salt-water rivers. When the tide runs out, the channels become long fingers of red mud.

Most Sea Shells Very Small

If you are a shell collector and are disappointed at the number of sizeable shells to be found on the average sea beach, just remember that most of the 100,000 species of seashells known and named are less than half an inch long, and many range down to microscopic size. On the other hand, a few would be much too large to bring home in a collecting basket, including a clam found in the Pacific which may grow as big as a caldron and weigh as much as 500 pounds.

About The Authors

L. NEWTON

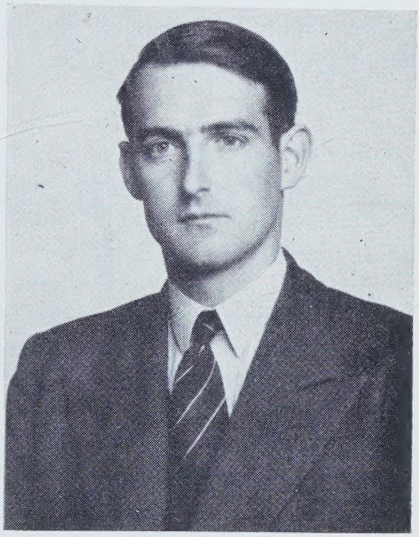
As a botanist, Dr. Newton is interested in land vegetation as well as seaweeds. But she is best known for her writings about the latter, including "Handbook of British Seaweeds," "Seaweed Utilization," and "A Study of Certain British Seaweeds and their Utilization in the Preparation of Agar." The latter she edited and was part author.

Dr. Newton also was responsible for the botanical surveys and harvests which led to the production of an agar in World War II. Her present research includes (a) "Chondrus crispus" and (b) water pollution by heavy metal effluent. Since 1930 she has been Professor of Botany at the University College of Wales, at Aberystwyth, and in 1952-53 served as Acting Principal.

G. H. ELLIOT

Mr. Elliot writes about Antarctic whaling from firsthand experience, having spent three whaling seasons in the storm-tossed waters of "the bottom of the world" during the past ten years.

He was educated at Oxford and served as a war-time officer in the Indian Army.



Mr. Elliot later joined the famous whaling concern of Chr. Salvesen & Co., of Leith, Scotland, in 1948, and is now a director. Salvesen, founded by Mr. Elliot's great-grandfather, has whaled since 1899, starting around Iceland and the Faroes, and has become one of the biggest concerns.

ALAN W. MOFFETT

Since Alan Moffett's original home was in Provincetown, Mass., on Cape Cod, he early developed an interest in the sea and marine science. He is a graduate of the American International College, Springfield, Mass., (B.A.), and of the University of Miami (M.S. degree in fisheries).

While attending graduate school Mr. Moffett spent one summer at Portland, Maine, working with the menhaden investigations conducted by the U. S. Fish and Wildlife Service. Now on the research staff of The Marine Laboratory, University of Miami, he is assisting in a survey of sportfishing in Florida, most of his research being devoted to tarpon and snook.

Progress

IN THE SHORT PERIOD of its life, *Sea Frontiers* has now reached a circulation of 15,000, not all of whom are members. They are drawn from the United States, Canada, Central and South America, Great Britain, Australia, France, Germany, Italy, Denmark, Sweden and Norway, as well as a few from the Pacific Islands and the West Indies. Continued improvement will be possible with growth of active membership. It will be seen in better service, with more articles in the Bulletin of high interest and authenticity and, eventually, a monthly issue in full color.

Members are joined in these aims and they are urged to make progress possible by taking the small effort needed to enlist new members. To those who are not members, but whose interest and curiosity lie in the sea and the spirit of discovery, there is extended an invitation to participate by simply mailing a card. The ocean is our last frontier and its exploration still under way.

The editor will be glad to consider for publication articles and illustrations covering explorations, discoveries or advances in our knowledge of the marine sciences or describing the activities of oceanographic laboratories or expeditions in any part of the world.

The International Oceanographic Foundation

"To encourage the extension of human knowledge by scientific study and exploration of the oceans in all their aspects, including the study of game fishes, food fishes, ocean currents, the geology, chemistry, and physics of the sea and the sea floor."

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The Foundation was established by a group of saltwater anglers, yachtsmen, shipowners, marine scientists and others interested in the scientific exploration of our last frontier, the ocean. Its objectives are to provide support and encouragement for marine research, exploration and discovery and to promote the collection and dissemination of scientific knowledge about the ocean.

Qualifications for membership are an interest in the oceans and a desire to extend and develop scientific research and exploration into them. Support given to research through personal activities or donations is recognized by the Foundation through the following classes of membership. Members are those who make annual contributions of $5, Fellows $25 annually; Associates $100 annually; Life Fellows are those who contribute $200 or more or who have otherwise helped to advance the purposes of the Foundation; Sponsors who contribute $1,000 or more; and Patrons who contribute $5,000 or more. Corporate Associates contribute $1,000 annually.

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